THE AIRPORT AND ITS NEIGHBORS

THE REPORT OF THE PRESIDENT'S AIRPORT COMMISSION

PRESIDENT'S AIRPORT COMMISSION

16 MAY 1952

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Washington • May 16, 1952

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Letter of Transmittal

The PRESIDENT,
The White House.

MAY 16, 1952.

DEAR MR. PRESIDENT:

We have the honor to transmit herewith our Report in response to your letter of February 20, 1952, in which we recommend action to alleviate certain immediate problems inherent in the present location and use of airports and, in addition, we propose policies and procedures designed to insure sound and orderly development of a national system of airports, to safeguard the welfare of the communities and to meet the needs of air commerce and the national defense.

An intensive study of all aspects of aviation that bear on the airport problem has been made. We have examined the record and have consulted with individuals and with organizations concerned with civil and military aeronautics and airport management. We have collected, compiled and analyzed the views and opinions of some 75 municipal governments of United States cities on the past, present and future of the airports in their communities and have visited 30 of the major airports of the country to confer with the local authorities and to see for ourselves what their problems and plans are.

In addition, we have obtained the views of civic associations representing people who live in the vicinity of airports but are not otherwise related to the aviation industry. Some of these groups were outspoken in their desire to be relieved entirely of the nuisance and exposure to potential hazard resulting from

aircraft operations in their vicinity. The majority were more moderate in their views. Recognizing that aeronautics is an essential element of our national economy, they asked only that all possible steps be taken to minimize nuisance and hazard.

All civil organizations and government agencies dealt with have been most helpful and cooperative.

While the problems associated with airport location and use are far too complicated to be adequately dealt with in ninety days, and will require continuing study, your Commission has carefully weighed all information that it has been able to obtain and is in unanimous agreement on the statements and recommendations expressed in this Report.

Respectfully yours,

J. H. DOOLITTLE, *Chairman.*
C. F. HORNE, *Member.*
J. C. HUNSAKER, *Member.*

Presidential Directive

THE WHITE HOUSE

FEBRUARY 20, 1952.

DEAR JIM: For some time now, I have been seriously concerned about airplane accidents, both commercial and military, that have occurred in the take-off and landing of aircraft, especially in heavily populated areas. I have been concerned about the loss of life and I have been concerned about the anxiety in some of our cities. I have decided to set up a temporary President's Airport Commission to look into the problem of airport location and use. I am delighted that you are willing to serve as Chairman of the Commission, and I hereby appoint you as such. Mr. Charles F. Horne, the Administrator of Civil Aeronautics, and Dr. Jerome C. Hunsaker, Head, Department of Aeronautical Engineering, Massachusetts Institute of Technology, will serve with you on the Commission.

The present location of many of our major airports was determined a number of years ago when the aviation industry was new and operations were relatively limited. Also some of the locations reflected special military requirements. Since that time both civil and military air traffic have been growing rapidly, and simultaneously our cities have been continuously spreading out toward these airports.

Meanwhile, there has been great progress in the art of flying and in the development of supporting facilities. Striking advances have been made in aircraft and power plant development, in speed and service, in operational control of aircraft and in their ability to operate under a wide variety of weather condi-

tions. A common system of navigation and landing aids, for both civilian and military use, has been installed and is being maintained by the Federal Government on the Federal airways and at important airports. At the same time, the Nation's investment in both civil and military airports has undergone tremendous expansion.

Our present mobilization efforts have greatly speeded up the tempo of these activities, particularly in the design and production of aircraft and the construction of facilities for the military services.

In view of these developments, I feel that the Nation's policy on airport location and use should be restudied. We need a study that is both objective and realistic. That is what I want your Commission to do. In undertaking this survey, several major considerations should be kept in mind. On the one hand, provision must be made for the safety, welfare and peace of mind of the people living in close proximity to airports. On the other hand, recognition must be given both to the requirements of national defense and to the importance of a progressive and efficient aviation industry in our national economy.

In addition to these general considerations, I would like the Commission to take the following specific matters into account.

1. The Federal, State, and local investment in existing civil and military airports and the factors affecting the utility of airports to adjacent communities.

2. Actions by Federal, State and local authorities to lessen the hazards surrounding existing civil and military airports.

3. Assignment of newly-activated military units to existing airports, with particular regard for potential hazards to the communities involved.

4. Site selection for new civil and military airports and the factors affecting relocation of existing airports.

5. Joint civil and military use of existing or new airports.

6. Legislation and appropriations necessary to carrying out appropriate policy.

Because of the urgency of the problem, I hope you will be able to give me your final recommendations within ninety days. In your work, you will have the full cooperation of all the Executive agencies whose functions and interests relate to your assignment. And you will want, of course, to keep in close touch with other groups concerned about this problem, including the Committees of Congress, local authorities and the aviation industry.

Arrangements will be made to meet the expenses of your Commission out of the Emergency Fund for the President.

Sincerely yours,

HARRY S. TRUMAN

MR. JAMES H. DOOLITTLE,
Vice President,
Shell Union Oil Corp.,
New York, New York.

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Part I

THE AIRPORT AND ITS NEIGHBORS

The Airport and Its Neighbors

Part I

Section 1. Summary

The task of the President's Airport Commission has been to consider means to safeguard the lives of people living in the vicinity of airports and to alleviate for them, as far as possible, the disturbance that arises from the operation of aircraft. As directed by the President, the Commission has studied these problems in the light of an urgent need for continued development of both civil and military aeronautics for the welfare and safety of this country.

Establishment of the Commission was an outgrowth of a sequence of tragic accidents in the New York-Northeastern New Jersey metropolitan area. The fact that these mishaps were confined, by coincidence, to a single community accentuated fears of many Americans that aircraft represent a serious hazard to ground-dwellers. They also served to increase awareness of nuisance aspects in the use of airports, particularly with regard to noise. As the result of a careful and detailed study of both hazard and nuisance factors, the Commission feels that a great deal is being done to protect the people; it also feels that more could and should be done.

Along with every other vehicle invented and used by modern man, aircraft suffer occasional accidents with resulting fatalities to their occupants. More rarely, people and property on the ground are also involved. Incidents of this sort are most likely to occur near airports because operations are somewhat more

hazardous at terminals than en route. Current improvements in equipment and in operational procedures, however, offer the possibility that accidents of all kinds will be further reduced. Accidents involving aircraft on airways and at air terminals should eventually fall well below rates now considered normal for other forms of commercial transportation.

The same favorable trend cannot be forecast as confidently for the nuisance factors. Exhaust mufflers and slow-turning multi-blade propellers of large diameter have been applied successfully to quiet small airplanes. As aircraft become larger and faster, the power required to propel them and the resultant noise multiplies many fold. Some noise reduction can be achieved, even in these large aircraft, by reduced propeller tip speed and by removing more energy from exhaust gasses, but reducing their noise to comfortable proportions still presents a difficult problem.

In the future, with wider use of high speed turbine-driven propellers or high thrust jet-propulsion, there will be a tendency for the volume of noise to increase beyond levels now experienced and for the character of the noise to become more objectionable. Research is now under way in these areas, but the problems are technically difficult and no effective solutions are in sight.

Airport Growth

The growth of air transportation has put a severe strain on many major airports. Original facilities for handling airplanes in the air and on the ground and for taking care of passengers, mail, express and freight in terminal buildings have been outgrown. Many airports are approaching saturation. Some of them are badly out of balance due to a deficiency in one or another of their facilities. For example, some of our large municipal airports now have traffic control capabilities permitting a great many landings and take-offs per hour but their runways or their servicing facilities on the ground have not kept pace. In some cases runways which were once adequate in strength

will not now support today's heaviest airplanes. Larger and faster airplanes making more landings and take-offs in worse weather will call for more adequate runways, larger clear approach areas and improved traffic control facilities and procedures.

Definite traffic patterns have been established by the Civil Aeronautics Administration at every major terminal airport in the country. These flight tracks have been designated after careful consideration of all flight safety factors. Serious efforts are being made to reduce ground hazard and noise. Eventually airports and their runways should be planned so that all approach and holding patterns minimize flights over thickly settled areas.

Tighter control of aircraft near airports must be achieved. To accomplish this, necessary equipment must be developed, procured and installed. Once adequate facilities are operational, positive traffic control at congested airports should be insisted upon at all times, even under what are now considered Visual Flight Rule conditions. The ceiling and visibility limits for VFR flights in congested terminal areas and the minimum ceilings and visibilities under which aircraft are permitted to circle and maneuver after instrument approach should be raised.

Airport use becomes more complicated when there is joint use by civil aviation and the armed services. In the interest of economy it is common practice for air defense, military air transport or air reserve training units to be based on municipal airports. Combat airplanes are generally noisy and will probably become noisier with the advent of more powerful jet types. Because of the noise of military operations (especially on week ends) and because accidents have occurred, people living near such airports have complained. Joint military and civil use of major airports is undesirable. Separation should be effected whenever it is economically feasible. Military training operations over thickly settled regions should be prohibited.

In some cases, manufacturing plants are located on busy civil airports and both experimental and production aircraft are

being flown from these airports. Recognizing the potential hazard involved, especially with the very fast jet types, some manufacturers have established test facilities on remote airports, and are making trial and shakedown flights away from congested areas. Whenever practicable this should be required. Flight delivery of production aircraft may be permitted under proper procedures and under conditions where nuisance and hazard to the surrounding community are reduced to the minimum.

Community Encroachment

Another aspect of the problem deals with the technical and economic forces which are pressing for airport expansion and which, in turn, are opposed by the encroachment of the surrounding community. Many communities are approaching an impasse arising from limitations to safe operation on existing airports combined with a physical inability to improve or extend them because homes or factories have been built close to the runway ends.

The pattern of development for major airports has been historically similar. Twenty years ago when airplanes were small in size and few in number, airport sites were selected at a distance beyond the city limits where ground was cheap and where few buildings obstructed the natural approaches to the field. Few then complained of the noise because it was infrequent and not very loud. As a matter of fact, this audible evidence of the arrival and departure of mail and passenger airplanes was often a source of local pride.

Normal growth, greatly augmented by the wartime movement of people to the cities, caused a spreading out toward the airport. Furthermore, the airport and its activities frequently acted as a magnet, drawing first the sightseer and then the businessman interested in concessions. Because desirable land was cheap, and a new and advantageous type of transportation was available, industries (sometimes aeronautical, sometimes not) settled near the airport.

LOS ANGELES—1939

LOS ANGELES—1949

Attached to all of these enterprises were people. People required homes within a short distance of their jobs. Speculators saw the opportunity to subdivide cheap land at a profit. Public utilities established primarily for the airport could be made available to the adjacent housing. Villages emerged, complete with shopping centers, schools, hospitals and recreation facilities. As a consequence, many municipal airports which were started less than two decades ago in the open country were progressively surrounded by residential and industrial areas.

The immediate problem is to find a way to protect present airports and the people residing near them by applying some means of control of ground use in approach zones. Local authorities should prevent further use of land for public and residential buildings near the ends of existing runways. If this is not done, new contingents of home owners will be added to the ranks of those who are now protesting against noise and hazard. In time public pressure may threaten the continued existence of the airport and large investments of public and private funds will be jeopardized.

Zoning

This Commission has two suggestions to make in this connection: (1) that certain extensions or over-run areas be incorporated in the airport itself, and (2) that larger areas beyond such extensions be zoned by proper authority, not only to prevent the erection of obstructions that might be harmful to aircraft, but also to control the erection of public and residential buildings as a protection from nuisance and hazard to people on the ground.

Many airports already maintain cleared areas beyond the ends of paved runways to reduce the danger from accidental over-runs on landings, or from aborted take-offs. The Commission feels that no new airport should be planned without clear and, if possible, level areas at least 1,000 feet wide and at

least one-half mile long beyond each end of the dominant runways. These areas should be incorporated within the boundaries of the airport.

Beyond such extensions, the problem of control of the use of the land in approach zones becomes more difficult because of the large area involved. For reasons shown elsewhere in this report, it would be desirable to protect approaches to dominant runways for a distance of at least two miles beyond the runway extensions. Such protective zones should be fan-shaped with a width of at least 6,000 feet at the outer ends.

Outright ownership of sufficient land at each end of the dominant runways would provide the best solution. There is no legal question but that airports engaged in interstate commerce are a public utility for which public funds may be expended. Also, there is no legal question but that States, counties and municipalities may join together to condemn land (where enabling legislation exists) outside the boundary of any one municipality for airport purposes. The cost of acquisition of sufficient land, however, is frequently beyond the capabilities of a single community.

Where it is not economically feasible to purchase such tracts of land so that absolute control of their use could be maintained, reliance must be placed on zoning laws to protect both the aircraft using the airport from obstructions to flight and the people on the ground from hazard and noise.

Although there are legal means to zone approach areas to protect aircraft from collision with obstructions, no zoning laws have been enacted to the knowledge of this Commission to control land use generally in approach zones. Consideration of basic property rights raises the question in both cases as to whether or not such control of use constitutes a "taking" of the property, and as such should be compensable to the owners.

Traditionally the power to control the use of land rests with the States and may be delegated to counties and local communities. The Federal Government should, however, propose model

airport protective legislation for enactment by the States, and should help where practicable toward reaching a satisfactory solution of this type of zoning problem.

It is recommended that the responsibility for zoning be left with the States and their political subdivisions, at least for the present, and until they have had a full opportunity to cope with the problem under adequate Federal guidance. It is further suggested that the Federal Government commit no funds for new airport construction unless the State, or other local authority gives reasonable assurance that the air approaches to the airport will be protected in accordance with the recommendations made herein. The land under the approaches should not be put to any use which might later serve as a basis for an effective argument that the space above should not be used by aircraft. Future residents should not be given any grounds for claims that aircraft approaching or departing from the airport, or which may be involved in accidents, create a nuisance which entitles them to an injunction, to recover damages or to demand that the airport be closed.

The suggestions made above apply particularly to new airports to be laid out in areas free from natural and artificial obstructions. Such ideal conditions are to be found in a very few localities desirably adjacent to sources of air traffic. For a long time to come, therefore, most airports must make the best of existing conditions even if they fall short of the ultimate airport specifications recommended here.

To promote the general welfare and to protect necessary systems of air transportation, it is essential that the major airports now engaged in interstate commerce, the postal service, or in defense activities be continued in operation. Furthermore, these airports must not be allowed to deteriorate. They must be continually improved to the greatest possible degree along the lines recommended. They should be made to approach the ideal airport as closely as local conditions permit. Local zoning authorities should employ their powers to prohibit further develop-

ments which will interfere with appropriate use of existing airports. Here also availability of Federal funds should be dependent upon such local action.

Federal Assistance

Federal aid for construction at airports was inaugurated in the early 1930's. The Federal Airport Act of 1946 set up a continuing program with an authorized maximum expenditure rate of $100 million per year. In general, the program called for financing airport projects on a "matching" basis, with the Federal Government providing grants-in-aid to the communities concerned. Unfortunately, this program has lagged because of inability to synchronize the availability of Federal and local funds. Such difficulties should be resolved at the earliest possible date. Priority of expenditure of Federal funds should be given to the lengthening of runways and to the acquisition of cleared extensions beyond the runways for incorporation in the airport.

Runway Design

A solution to many aspects of the airport problem is, in the opinion of the Commission, the early acceptance of the single or parallel runway design of airport with approaches over relatively clear areas. By this means, airport development could proceed along economical lines with minimum hazard and annoyance to neighbors. The single or parallel runway airport has one shortcoming—difficulty of operation in strong cross-winds—but this is being overcome through pilot training techniques, the use of tricycle gears and the further development of special cross-wind landing gears.

Too much emphasis has been placed on statistics of prevailing winds, including light and variable airs of little consequence in modern flying practice. As a result large sums still are being programmed unnecessarily for multiple intersecting runway airports, and too little consideration is being given to the hazard

zones off the ends of these same runways. Simplified traffic control, economy of navigational aids, more effective use of radar, less airport acreage, room for expansion, protected runway extensions and smaller paved areas are favored by an oblong rather than a square airport. This is a principle that can be applied to new airport design and, in many cases, to present airports which are being hemmed in on some sides by residential areas. However, where high cross-winds are prevalent an additional but shorter runway, oriented at 90° to the dominant runway, will be needed for some years.

Runway Length

Some manufacturers suggest that future transport airplanes (derived from current long-range high speed bombers) could be designed to have a marked gain in performance and efficiency if airports with runways several miles long with clear, flat approaches of several additional miles at each end were available. Such configurations for a few new airport projects might prove economically feasible, but for existing municipal airports such extensions are impractical. There are very few sites available within reasonable distance of population centers where airports with extremely long runways could be built. A well balanced system of civil air transportation, adequate to meet the needs of national defense, air commerce and the postal service calls for a wide-spread network of airports of reasonable size with the future to determine the requirements for a few "super" airports at strategic points for very long-range routes.

Most municipal authorities consulted by this Commission wish to retain their present airports. They urge that current standards of runway length be "frozen" and remain in effect for a substantial period of time in order to protect their already large investment. They argue that airplane designers should apply the results of research and invention to the improvement of the safety, performance and economy of their products within existing runway length limits.

Standard runway lengths for different categories of airports have been proposed. As many airports as possible should bring themselves up to these standards. It seems to this Commission that major air terminals should eventually provide principal runways, for the use of transcontinental or intercontinental airplanes, that are at least 8,400 feet long. A length of 10,000 feet should accommodate all types of practical transport airplanes now forseen. Additional runway length would provide an additional safety factor but should not be required for normal operations.

A future change in the established standards for runway length should come only after compelling considerations. Its effect on the air transport industry would be world-wide. Few principal civil airports could undertake any substantial increase in runway length, and a new system of airports would have to be undertaken.

While runway length standards are desirable, it appears undesirable to specify a long term standard for strength of runway construction, or to attempt to limit airplane designers on airplane weight or wheel loads. Airports should be designed for the greatest wheel loads anticipated, and in the event that runways prove inadequate in strength for future airplanes, they can be reinforced or rebuilt.

Nuisance Factors

Some excuse may be found for failure to have foreseen the rapid rate of aeronautical progress in designing airports in the past, but it is to be regretted that more consideration was not given to the comfort and welfare of people living on the ground in the vicinity of airports. To be sure, many settled near an airport after it was in operation, with little realization of the potential nuisance and hazard. The public cannot be expected, however, to anticipate technical developments and it should be informed and protected by the responsible authorities.

The public deserves a clear explanation of necessary airport

procedures, accompanied by valid assurances that everything possible is being done to alleviate both noise and hazard. For example, in low visibility, incoming aircraft sometimes must be "stacked" near an airport under precise traffic control to prevent collisions. The public will understand and accept this necessity if it is assured that, within the limit of safe operation, the holding areas are selected so that the stacks will not be a source of nuisance. Also where operators are making a sincere effort to reduce engine run-up noise by controlled ground procedure and by the provision of proper acoustical treatment, and are avoiding take-offs over inhabited areas, reasonable people can be persuaded to tolerate some noise as a part of the cost of living in this age of technology. Operators, pilots and airport controllers must be indoctrinated to consider the people on the ground and make every effort consistent with safe flying practice to reduce hazard and noise.

Aircraft designers and manufacturers must also assume a share of the noise alleviation task. So far, they have been concerned mainly with noise levels inside the airplane. They should also strive to minimize noise outside the airplane. If the manufacturer is given a penalty for high noise or better yet a premium for low noise level, it will stimulate competition in the development of quieter aircraft.

Standardization and Training

It is believed that through standardization and training, accidents due to pilot error can be reduced. There is, at the moment, a regrettable lack of uniformity of design and arrangement of transport aircraft cockpits. Not only is there variation between different types of aircraft, but also variations in the same type, depending on the ideas of individual airlines. A useful step in improving the training of pilots in emergency procedures would be the standardization and simplification of equipment in cockpits. Simplified emergency procedures naturally would

follow. The pilot's job would be easier and safety would be increased.

More training in emergency procedures should be required. Simulated emergency drills, in airplanes without passengers, should be conducted periodically. Such training flights should, of course, be conducted over uninhabited areas. A method of training flight crews without hazard is through the use of flight simulators. These are complicated devices duplicating the cockpit and flight deck of the airplane. The equipment and instrumentation are operated by an instructor to simulate various emergency conditions. The crew then deals with the situation as it would in flight. Necessary practice is thus provided without risk. Since flight simulators are expensive and one i required for each type of aircraft, it may be necessary to purchase and use them on a cooperative basis.

Airport Planning

Alleviation of presently undesirable conditions is not enough. Policies and plans for the future must take into account trends in the air transport system of the nation. This will require continuing study.

It is to be expected that air transportation will continue to develop at a rapid rate. Municipalities should anticipate this expansion. They should plan for it and prepare to finance their share of it. Plans should include improvement of existing airports up to the point of balanced saturation and also the purchase of land required for additional airports some years before saturation is reached. If the latter is not done, the purchase cost will be much greater and the chance of obtaining and protecting a desirable site correspondingly reduced. Insofar as topography, present land use and economics will permit, the airport should be as close as possible to the center of the area from which air traffic originates. Comprehensive forward planning is essential to the establishment of efficient, economical, nuisance-free airports.

Such planning may require changes in the laws that govern the use of the navigable airspace, including the flight path to and from airports. Coordination and standardization in the development of airports used in interstate commerce are necessary. It is possible that the future will call for a system of airports for a metropolitan area with separate facilities for certain types of air traffic. This involves regional and city planning and particularly questions of interconnecting highway and air services and the integration of the air and ground traffic. It also implies successful development of short-haul aircraft, possibly of the helicopter type.

The inadequacy of our present road network, particularly in the vicinity of major cities and between city and airport, is one of the greatest deterrents to the further development of transport aviation.

Navigable Airspace

As a result of fear engendered by low flying aircraft, several communities have recently passed local ordinances prohibiting flight over them at altitudes less than 1,000 feet. Along airways, such regulations would present no problem. They could, however, severely hamper approaches to certain airports. It is anticipated that the courts will shortly be called upon to decide this question.

This Commission believes that the Federal Government, through the Civil Aeronautics Board and the CAA, now has authority from Congress to regulate and determine approaches for airports used in interstate commerce. Accordingly, the CAA should determine what is the best approach pattern for a particular airport, and should then declare that the "safe altitude" in that area is in conformity with the airport approach pattern. Pursuant to the Civil Aeronautics Act of 1938, this should mean that there is a "public right of transit" in accordance with that airport approach pattern. If the pattern appears to depreciate property values of underlying landowners, the Federal Government might, if funds are made available by the Congress, exer-

cise the power of eminent domain to acquire title to the land. If an easement through the airspace is involved, it appears that additional legislation would be required.

Airport Certification

It is clear that commercial airports are instrumentalities of interstate and foreign commerce. As such, they have a definite public character. Their continued efficient operation vitally affects interstate commerce, national defense, and the postal service. They are, however, at the present time subject to little Federal regulation. The Commission believes that such regulation should be kept to a minimum, but also believes that more authority over such airports is required than is now provided by Federal statutes.

The Civil Aeronautics Act authorizes the Administrator to inspect, classify and rate any air navigation facility (which includes airports) as to its suitability, and to issue certificates for any air navigation facility. But the Act does not require the issuance of a federal certificate to airports, nor does it make unlawful the operation of an airport without a certificate.

The Civil Aeronautics Act should be amended to require that certificates shall be issued for the operation of airports used in interstate commerce. Such certificates should define minimum standards for safe operation and proper maintenance and should be revoked if such standards are not met. The abandonment of such certificate or the closing of an airport for other reasons, however, should not be permitted except after notice and hearing and due finding that the proposed action is in the public interest.

Section 2. Recommendations

The Commission feels that definite arrangements should be made and specific governmental agencies designated to develop and to implement the following recommendations:

1. *Support required airport development.* New airports will be needed and present airports must be improved. State, county

and municipal governments should be prepared to assume their proper share of this expense.

2. *Expand Federal-Aid Airport Program.* Authorization of matching funds for Federal aid to airports should be implemented by adequate appropriations. Highest priority in the application of Federal aid should be given to runways and their protective extensions incorporated into the airport, to bring major municipal airports up to standards recommended in this report.

3. *Integrate municipal and airport planning.* Airports should be made a part of community master plans completely integrated with transportation requirements for passenger, express, freight and postal services. Particular attention should be paid to limited access highways and other transportation facilities to reduce time to the airport from sources of air transport business.

4. *Incorporate cleared runway extension areas into airports.* The dominant runways of new airport projects should be protected by cleared extensions at each end *at least* one-half mile in length and 1,000 feet wide. This area should be completely free from housing or any other form of obstruction. Such extensions should be considered an integral part of the airport.

5. *Establish effective zoning laws.* A fan-shaped zone, beyond the half-mile cleared extension described in Recommendation 4, at least two miles long and 6,000 feet wide at its outer limits should be established at new airports by zoning law, air easement or land purchase at each end of dominant runways. In this area, the height of buildings and also the use of the land should be controlled to eliminate the erection of places of public assembly, churches, hospitals, schools, etc., and to restrict residences to the more distant locations within the zone.

6. *Improve existing airports.* Existing airports must continue to serve their communities. However, cities should go as far as is practical toward developing the cleared areas and zoned runway approaches recommended for new airports. No further

building should be permitted on runway extensions and, wherever possible, objectionable structures should be removed. Operating procedures should be modified in line with Commission recommendations for minimizing hazard and nuisance to persons living in the vicinity of such airports.

7. *Clarify laws and regulations governing use of airspace.* Authority of the Federal, State or municipal governments with respect to the regulation of the use of airspace should be clarified to avoid conflicting regulation and laws.

8. *Define navigable airspace in approach zones.* The limits of the navigable airspace for glide path or take-off patterns at airports should be defined.

9. *Extend Civil Aeronautics Act to certificate airports.* The Civil Aeronautics Act should be amended to require certification of airports necessary for interstate commerce and to specify the terms and conditions under which airports so certified shall be operated. Certificates should be revoked if minimum standards for safety are not maintained. Closing or abandonment of an airport should be ordered or allowed only if clearly in the public interest.

10. *Maintain positive air traffic control.* Certain air traffic control zones in areas of high air traffic density should be made the subject of special regulations to insure that all aircraft within the zone are under positive air traffic control at all times regardless of weather.

11. *Raise circling and maneuvering minimums.* Present straight-in instrument approach minimums are considered satisfactory but the minimum ceilings and visibilities under which aircraft are permitted to circle or maneuver under the overcast in congested terminal areas should be raised.

12. *Accelerate installation of aids to air navigation.* Research and development programs and installation projects designed to improve aids to navigation and traffic control in the

vicinity of airports, especially in congested areas, should be accelerated. Installation and adequate manning of radar traffic control systems should be given high priority.

13. *Revise present cross-wind component limits.* Existing cross-wind component limitations should be reviewed to establish more liberal cross-wind landing and take-off specifications for each transport-type aircraft.

14. *Develop and use cross-wind equipment.* Although modern transport aircraft can operate successfully in any but very strong cross-winds, the further development and use of special cross-wind landing gears should be accelerated.

15. *Extend use of single runway system.* New airports should adopt a single or parallel runway design. This should be adequate except under strong wind conditions, in which case a shorter runway at 90° to the main one may be required. Present airports should plan to develop the dominant runway at the expense of those less used. Airport expansion should be achieved through additional parallel runways.

16. *Meet standard requirements for runway length.* For each category of airport a standard runway length has been established consistent with its future planned use. Airports should bring their runways up to the standard. For intercontinental or transcontinental airports, the length of the dominant runways should be 8,400 feet with possibility of expansion to 10,000 feet if later required and with clear approaches as per Recommendations 4 and 5.

17. *Accelerate ground noise reduction programs.* Engine run-up schedules and run-up locations should be adjusted to minimize noise near airports. Adequate acoustical treatment in run-up areas and at test stands should be provided.

18. *Instruct flight personnel concerning nuisance factors.* A tight discipline with respect to airport approach and departure procedures to minimize noise nuisance to people on the ground

(within the limits of safe operating procedures) should be maintained at all times.

19. *Arrange flight patterns to reduce ground noise.* Airways and flight patterns near airports should be arranged to avoid unnecessary flight over thickly settled areas to minimize noise, but only within the limits of safe flight practice.

20. *Minimize training flights at congested airports.* Flight crew training should be conducted, as far as practicable, away from thickly settled areas and with a minimum number of flights into and out of busy airports.

21. *Minimize test flights near metropolitan areas.* Production flyaway from aircraft factories under proper conditions is acceptable but all flights of experimental aircraft and test flying of production models near built-up areas should be reduced as far as possible.

22. *Avoid military training over congested areas.* Although the basing of reserve air units at airports near cities has been considered generally desirable, and the location of certain combat units there is sometimes necessary, training maneuvers, particularly with armed military aircraft, should be conducted only over open spaces. Rapid shuttle service to an outlying military training field offers minimum interference with civil air operations and maximum safety and freedom from nuisance to people on the ground.

23. *Separate military and civil flying at congested airports.* Military aircraft should not be based on congested civil airports except when it is not economically or otherwise feasible to provide separate facilities for them nor should commercial aircraft operate regularly from busy military airports.

24. *Provide more flight crew training.* Every flight crew should be required to have frequent drills in instrument and emergency procedures. This can be accomplished in part in flight simulators. These flight simulators should be located at

convenient points and should be available to all operators on a fair basis.

25. *Develop helicopters for civil use.* Concurrent with military helicopter development, interested government agencies should encourage civil helicopter development for inter-airport shuttle services, and for short-haul use, emphasizing safety, reliability and public toleration factors.

Part II

AVIATION—
A NATIONAL ASSET

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Part II. Aviation—A National Asset

In the short span of fifty years since the invention of the airplane, aviation has become essential to our national defense and indispensable to our national economy. Although only a fraction of our total population is directly engaged in the design, manufacture or operation of aircraft, every citizen is an indirect beneficiary.

As for direct employment, aviation manufacturing was in third place among U. S. industries in February 1952. Only automobiles and steel were ahead. The Aircraft Industries Association has further estimated that by the end of 1952, it will move up to second place with over 750,000 employees. This does not take into account the very large number of people who are indirectly engaged in aviation through the supply of fuel and oil, apparatus and equipment. A large part of the radio and electronics industry is producing items of special equipment for aircraft, airways and airports. At present, the total backlog of manufacturing orders is estimated by the Aircraft Industries Association at more than $12 billion.

United States airlines last year did approximately $776 million worth of business. They are also a major employer of people. Nearly 90,000 persons now work for the airlines of this country. The business of air transportation is spread over all parts of the United States and contributes to the welfare of many communities.

It is significant that the mayors who replied to the Commission's questionnaire were unanimous in their view that aviation is a substantial contributor to the wealth of their cities. Throughout the country, large numbers of small aircraft are

used for agricultural and business purposes as well as for personal flying. They also add to the nation's wealth.

Aviation is potentially one of the great social forces of our time. Commerce and banking, farming and industry, businesses large and small, and all the people whose livelihood depends upon communication and cooperation with others at a distance would suffer incalculable loss if the full use of the navigable airspace were restricted.

But in spite of remarkable progress in the past fifty years, it must be recognized that air transportation is still in an early stage of its development. Other transportation systems, on land and sea, have many years of experience behind them. Modern air transportation is new to this generation.

Only a few years ago, the best of our aircraft were relatively underpowered and unreliable and could be flown safely only in favorable weather. Accidents were not infrequent. Now, thanks to progress in the aeronautical sciences and to the enterprise of designers, builders, and operators, we have reliable and efficient transport aircraft, a national system of airways and aids to navigation, good airports and excellent communication and weather reporting services. The 20 million passengers who flew on airlines of the United States during 1951 were exposed to less hazard per mile covered during their flights than they were while traveling to and from airports in automobiles.

Great progress has been made in convenience, reliability, safety and economy for the air traveler. Large outlays in effort and of money are being made to maintain and to improve safety and efficiency. However, the fact that accidents sometimes occur indicates that we must continue to strive for improvement.

Specific recommendations that should be helpful, so far as concern the location and use of airports, are listed in a preceding section of this report and are discussed in the sections that follow.

Part III

THE AIRPORT AS A LOCAL PROBLEM

Part III. The Airport as a Local Problem

Section 1. Airplane Characteristics and the Airport

The performance characteristics of airplanes largely determine the design of the airports built to serve them. On the other hand, facilities of existing airports limit the flight characteristics of airplanes designed to use them. Progress in the art makes possible the design and construction of larger and faster airplanes of greater efficiency and economy. These in turn demand longer and stronger airport runways with better clear approaches and better control of traffic.

While airports cannot be extended every time a new transport airplane is proposed, progress in the aeronautical sciences must be anticipated by the airport designer to provide necessary margins against early obsolescence.

The landing speed of an airplane is of primary importance in determining the runway length needed for its safe operation. This speed is closely associated with the airplane's maximum speed and cruising speed. It is, therefore, significant to examine the historical rise in airplane speed records and to project the trend to obtain a rough forecast of the future. Such a projection must be considered with due reservation for unpredictable inventions and discoveries of a fundamental nature.

Since 1903, when the Wright Brothers first flew at Kitty Hawk at a speed of about 40 mph, the speed record has increased consistently at a rate of about 14 mph each year (fig. 1) to the current mark of 670 mph, established by an F–86 fighter airplane in 1948. More recently, special research airplanes have flown faster than the speed of sound but such supersonic airplanes were rocket propelled for a flight of very brief duration

and thus are of little immediate interest as an index of practical transport operating speeds.

The lower curve in figure 1 shows the variation in the maximum speed of transport airplanes since the middle 1920's, when commercial air transportation was first established in this country. This speed has increased from 115 mph to 480 mph. Thus the rate of increase corresponds closely with the trend of world speed records, except that transport speeds have consistently lagged by 10 to 20 years. This presumably represents the period required to develop and utilize commercially the technical advances which made each new world speed record possible. It should be appreciated that the transport speed curve does not represent the maximum speed possible in transport airplane design at any given time, but reflects the compromise in speed, safety and efficiency that goes into the design of a practical transport airplane.

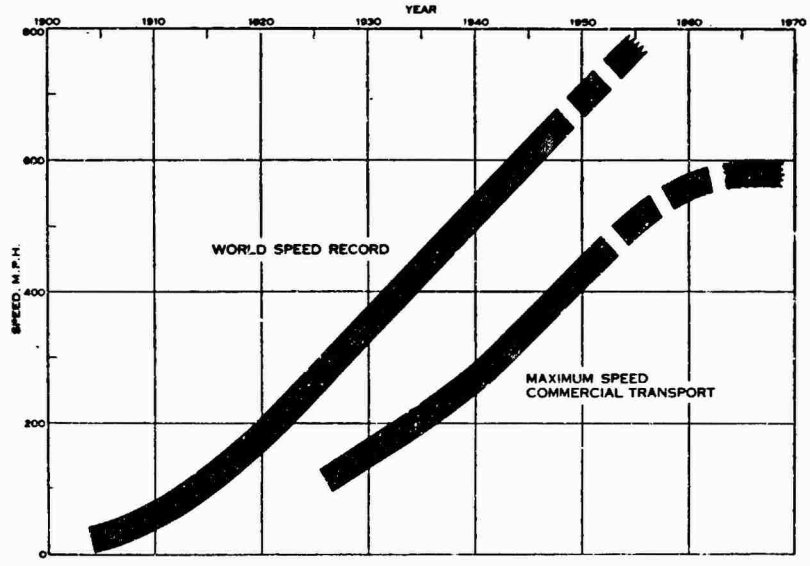

FIGURE 1. In the past, a 10- to 20-year lag between world speed records and the speed of commercial air transports has been normal. For the future, approach to the speed of sound will reduce the rate of speed increase of commercial air transports.

It might be thought, in view of the great current effort to increase the speed of military airplanes, that the future rate of speed increase for commercial carriers would be no less than in the past and perhaps even greater and, therefore, that their maximum speed might be about 670 mph 15 to 20 years from now. Such an increase will be delayed because of the rise in airplane drag and the associated reduction in airplane efficiency which occur as the speed of sound is approached. Nevertheless, current research indicates that the industry will be able, within 10 to 15 years, to build practical transport aircraft that will fly at speeds of 85 to 90 percent of the speed of sound. Within 20 years such airplanes probably will be in common use. At the altitude at which these airplanes will be flown this means 560 to 600 mph.

While maximum and cruising speeds have a direct effect on air traffic patterns and control, the speeds of most importance to airport design are those at which the airplane contacts the runway on landing and leaves the runway on taking off.

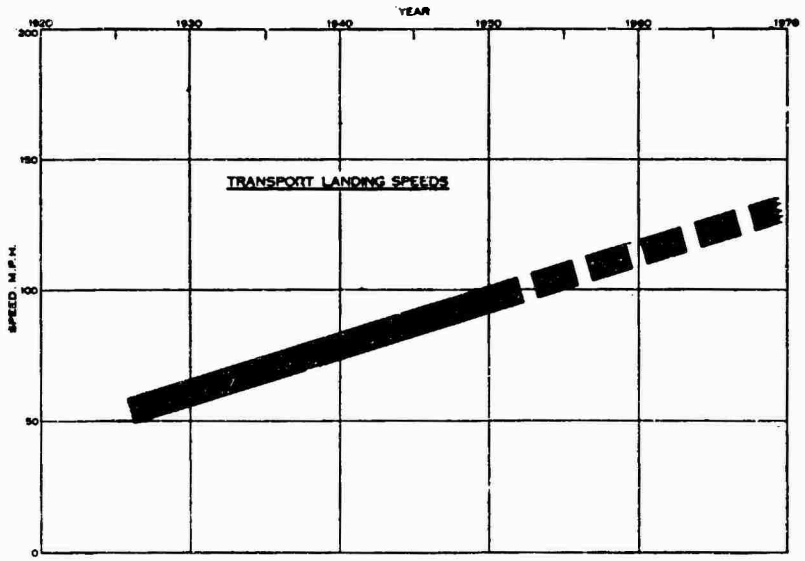

FIGURE 2. Landing speeds will go higher. This means longer runways for airplanes of the next decade, but the 8,400 to 10,000-foot lengths recommended will be adequate.

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Current trends indicate that the landing distance rather than the take-off distance will probably become the critical factor. Hence the discussion which follows is concerned primarily with landing distances.

The manner in which the minimum landing speeds of transport airplanes has varied in the past is shown in figure 2. These speeds have increased steadily from 50 mph to 100 mph. Thus while maximum speeds have increased fourfold, aerodynamic development of the lifting characteristics of wings, including such devices as flaps, and improvement in the low-speed flying qualities of airplanes have held the landing speeds to a twofold increase.

Modern transport airplanes land at about 100 mph. If the trends established in the past are projected into the future, landing speeds of 120–130 mph are indicated in about 15 years. A knowledge of how landing distance increases with landing speed leads to the conclusion that the required runway length would then be 45 to 70 percent greater than now. Present minimum runway requirements for airplanes with 100 mph landing speed are roughly 6,000 feet. Unless the designer improves landing and braking characteristics, the future 120 to 130 mph jet aircraft would need a runway 8,400–10,000 feet long.

Increase in take-off and landing speeds will have an important effect on the paths followed by the airplane on approaching and leaving the airport. Higher speeds normally result in more shallow paths, and the slope of the path decreases in proportion to speed along the path.

For a predicted increase in landing speeds to 120–130 mph, the paths may be 20 to 30 percent flatter than those now encountered. Unless means are developed to offset this trend, such as air brakes for the landing approach, the existing clearance requirements for airport approaches may have to be modified accordingly.

An additional effect of higher landing speed is that the radius of turn of the airplane in flight is larger. A higher approach

speed, larger turning radius and flatter path will make it more difficult to judge the exact point of contact with the runway, with the consequent greater possibility of undershooting or overrunning. These trends with regard to approach and climb paths emphasize the necessity for the planning of larger clear and unobstructed zoned areas beyond the ends of the runways.

The ability of present day aircraft safely to fly contact under low ceiling and visibility is less than that of the small, light and slow planes of the past. For airplanes of the future this capability will be further reduced as their speed increases. On the other hand, the ability of airplanes under modern instrument control to approach—straight in—and land, regardless of weather, is increasing steadily through the development of improved electronic aids and techniques.

While the size and weight of the airplane have no specific bearing on the over-all size of the airport, they do affect the required strength of airport runways, taxiways, and aprons, and their widths and space requirement. Transport airplanes have shown a pronounced and steady increase in size with time. Development of improved structural techniques, materials, and power plants has made this increase possible, but the actual size at any one time has been dictated largely by economic considerations, such as load potentials, operating costs and trip frequency requirements. Such considerations make it difficult to make any timed prediction of size. Experience has shown, however, that the bomber of today is frequently the transport of tomorrow and, since at least one bomber of about 350,000 lb. weight and a cargo adaptation of it at 320,000 lb. exist today, it is not unreasonable to expect that within the next 15 to 20 years commercial transport airplanes of this size will be in use.

Section 2. Airport Characteristics and the Airplane

A century ago, no coastal city could hope to survive economically if its harbor were undredged and treacherous and its docking facilities could not safely and efficiently accommodate the

merchant carriers of the sea. Today every major city in the United States has become a port for merchant carriers of the air. A city's economic health now depends to a considerable degree on its ability to accommodate aircraft safely and efficiently.

No airport exists by itself, and the usefulness of each depends upon the quality of its neighbors. Fundamental to U. S. air transportation is a well-integrated system of airports which provide adequate facilities both at origination and destination points.

To formulate such a system it is necessary (1) to determine present and future airport needs for all types of communities and various air operations; (2) to evaluate existing facilities; and (3) to propose such additional facilities as may be needed to safeguard human life—both in the air and on the ground—and to expedite transport traffic. Fortunately, in airport design, safety and efficiency are not opposing factors. The most efficient runway pattern provides the greatest safety for persons living in the vicinity of airports, as well as to passengers in the aircraft.

The trend in transport design is toward larger, heavier and faster airplanes. Such craft, because of their flatter approaches and take-offs and their noisier operation, represent a greater nuisance to persons directly beneath them than do lighter, faster-climbing airplanes. They have, however, compensating virtues. Unlike older designs, which have tailwheel landing gear, most modern transports are equipped with tricycle landing gear and are capable of landing or taking off across winds in the range of 20–30 mph. Even so, most pilots still prefer into-the-wind landings and take-offs. The air transport industry has shown a tendency to ignore present CAA and military standards, which stress that runway orientations should not be affected by cross-wind components below 15 mph. Acceptance of these standards, together with further study of cross-wind operations (including the equipping of aircraft with castering wheels), means that single or parallel runway principles can now be applied to most existing airports as well as to future installations. From a stand-

point of ground safety, it means that the hazardous areas—the approach and take-off zones—can be limited to the projections of single or parallel runways.

The Commission feels that one runway (or parallel runways) airport configuration is of great importance, not only from a standpoint of safety but in the interests of efficiency and future expansion. While an abrupt transition to the single direction pattern is not possible at existing airports, and with certain existing aircraft, steps in this direction are strongly advocated.

Present, multi-directional airports can "phase out" extra runways gradually, as the aircraft requiring these runways themselves become obsolete. The CAA already has made a cautious step in this direction, in certain congested areas, with the "preferential" runway system. Under this concept, cross-winds up to 15 mph are accepted before the designated take-off or landing runway is changed by the control tower. This plan is good as far as it goes. Its weakness lies in the fact that no airplane is assumed to have a greater cross-wind tolerance than 15 mph. This is by no means the case. The faster the aircraft, and the higher the wing-loading, normally the less the effect of a cross-wind on it.

Commercial reluctance to adopt a special cross-wind landing gear is easily explained. So long as multi-runway airports are available there is no advantage to an operator in adopting a special type of landing gear. Widespread acceptance of the dominant runway concept would spur the rapid development of adequate cross-wind gear. A successful tricycle version of the gear is already in existence on an Air Force C–54, and extensive tests indicate that landings in cross-winds of 40 mph present no problem. Thus, a solution appears readily possible from an engineering standpoint.

If a single runway becomes inadequate, additional runways should be parallel to the first. A separation of at least 3,000 and preferably 4,000 feet provides maximum efficiency under all weather conditions for simultaneous use. The land area between

runways offers an excellent location for terminal buildings, hangars, service areas and similar facilities. Consideration should be given to construction of a second direction runway only when compelled by local wind conditions. If it is determined to be essential, it should be oriented at 90° to the original runway and may be designed with a compensating reduction in length based on the wind velocities that make it necessary.

Establishment of the single or parallel runway pattern reduces the hazard around airports by limiting approaches and departures to two relatively narrow zones. It does not, of course, eliminate the ground hazard in those specific zones unless they be cleared to allow for emergency landings. An extension or over-run area at least one-half mile long and 1,000 feet wide should be provided, as an integral part of the airport, at each end of the runway. This area should be clear of structures and free of natural obstructions which might interfere with approach clearances. In the event it becomes necessary to lengthen the runway, these half-mile areas should be comparably extended. Beyond the runway extensions, a fan-shaped zone at least two miles long should be established in which land use can be controlled. This zone should be 6,000 feet wide at its outer limits. It should contain no schools, hospitals, churches or other places of public assembly, and no buildings tall enough to constitute flight path obstructions. Use of this land should be restricted to agricultural purposes so far as possible with residential buildings confined to its more distant sections. Factories, though less undesirable than housing in the zoned areas, should be located off the sides of the airport.

It must be realized that the foregoing represents an ideal to be striven for. Existing airports must continue to serve their communities even though they cannot be expected to meet all of these criteria. However, no further building should be permitted in runway extension areas and every effort should be made to approach the specifications set forth. In selecting sites for new airports, some compromises also may be necessary. A

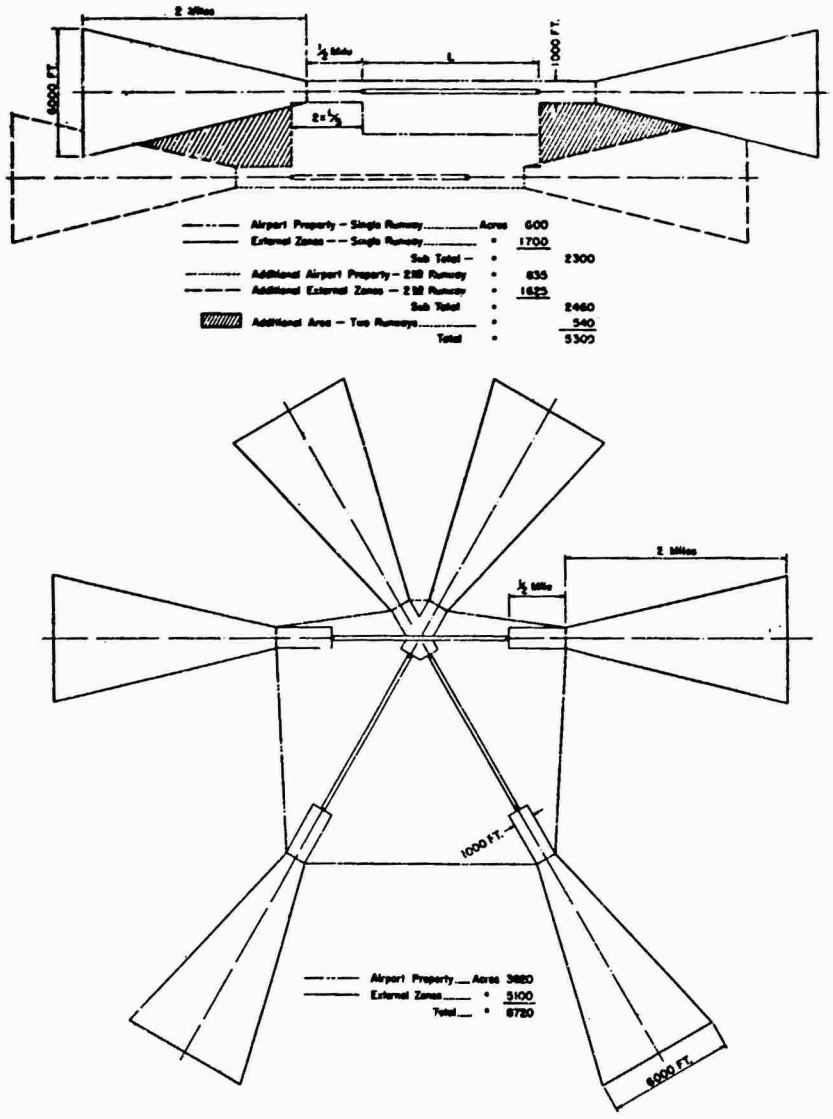

FIGURE 3. The single (or parallel) runway airport requires less acreage than the conventional "all way" field. Both patterns shown above have the same runway end-zone protection, but the parallel pattern (top) shows a saving in total land required of nearly 40 percent.

prospective site should not be ruled out arbitrarily because in some particulars it falls short of the ideal. Factors of cost, use, service and convenience must be balanced with optimum design.

Building for the Future

The interrelation between progress in airplanes and the airports built to serve them is discussed in section 1 above. The conflict between the fixed nature of ground facilities and the changing nature of the airplanes that use them creates many problems for the airport designer. The life span of an airport, taking into account its planned possibilities of expansion, should be at least 20 years if it is to justify the original investment.

Air transportation has now reached a stage of relative economic and financial stability such that airports may be incorporated into regional and city development plans with the expectation of a useful life comparable to that of railway terminals and harbor and dock facilities.

The question of whether fixed airport facilities should control future airplane design is highly controversial. To say that the average-capacity airport should be the limiting factor in airplane design is to place undesirable inhibitions on progress. Conversely, complete latitude in airplane design makes long-range planning for a well-integrated airport system difficult or impossible.

At present and for the foreseeable future, the Commission believes that most communities will be adequately served by airports conforming to the criteria set by Technical Standard Order N6a, issued by the CAA. For normal types of operation performed within the continental limits of the United States, airplane designers should concentrate on developing aircraft that can operate readily from the 8,400-foot (sea level) runways specified in T. S. O. N6a. Emphasis should be placed on improved safety, performance and economy of airplanes designed to utilize such airports.

The Commission envisions future airplanes whose economical

and operational characteristics may require super-airports. Such super-airports, designed especially for exceedingly fast and heavy transports for long-range intercontinental and continental routes, may need runways with lengths in excess of 10,000 feet and with strength to support loads above 300,000 lb. When the necessity for such airports arises—and it is unlikely that more than half a dozen will be needed—it is obvious that they will have to be located at a considerable distance from metropolitan centers.

The distance of the super-airport from the metropolitan complex it will serve poses intermediate transportation problems. For passengers, ground travel to and from super-airports might be replaced by air taxi service, possibly employing helicopters. Facilities would be needed to receive and dispatch feeder aircraft, similar to those now serving short and medium-range hauls. For the successful operation of the super-airport exceptionally thorough planning will be needed, and high construction costs almost certainly can be anticipated. Hence, the super-airport should be designed to serve (through expansion, if necessary) for an indefinite period.

Design and Construction

Apart from questions of general configuration, good airport design must solve problems of runway dimensions, taxiway pattern, and ground traffic.

Runways. Four factors govern runway construction—length, width, grades and strength. Of these, runway length is of the greatest concern in airport planning. The landing and take-off characteristics of a loaded airplane determine what lengths are necessary. The lengths quoted in T. S. O. N6a are for sea level, at standard temperature of 59° Fahrenheit, and zero gradient. They increase with elevation, temperature and gradient, so that an airport located at a 4,800-foot altitude, for example, with a mean temperature of 80° based on the average for the hottest month of the year, and with a one-fourth of 1 percent effective

gradient would require a runway 14,000 feet long. This figure is based on the 8,400-foot standard.

The strength of a runway is subject to dynamic and static test. A parked aircraft with dead engines transmits a static load equal to its own gross weight. The transmitted load decreases as the aircraft taxis, and continues to decrease as the taxiing-speed increases until it reaches zero as the machine is airborne. Impact loads on landing and high speed moving loads are less critical than static loads—a condition reflected in the greater wear shown on taxiways, aprons and run-up aprons.

Airport pavements are designed to provide adequate support for the loads imposed by aircraft, as well as a firm, stable, durable, smooth, all-year, all-weather surface, free from dust or particles. Because soil engineering is not an exact science, it has not been possible to derive a formula that will provide a direct mathematical solution to pavement design. However, recent re-evaluation of design criteria issued by Federal agencies has indicated that they are sound. Downward deviations from the criteria have proved to be unsound, costly and, in some cases, dangerous. It is not necessary to establish runway strength on a basis of estimates of weights and loads of projected aircraft. Airport pavements, like highway pavements, can be strengthened by overlays as load usage increases.

Taxiways. Runways should be used by aircraft only in take-offs and landings. It is essential to have well designed taxiways so that the aircraft can move expeditiously from or to runways, loading and servicing areas, and hangar and storage areas.

Run-up aprons. Between each runway end and the taxiways, run-up aprons are desirable because they afford flexibility in the choice of take-off sequence. The size of the run-up apron will depend principally on the rate of peak traffic on the particular runway.

Guidance. Pilots should be provided with proper routes of travel from or to a runway and with guidance indicators such as

taxiway lights. To reduce radio talk between the pilot and traffic controller, signs readable both in daylight and at night should be installed along the runway to indicate turn-off points and destination areas. The runways should be marked by a uniform and well-defined pattern, of distinctive shape and color, painted on the paved surfaces. The pattern should be of such composition that it is readily discernible to a pilot upon touchdown, informing him of his location and providing a further guide to turn-off points. This is particularly important on long runways and under conditions of low visibility. High intensity approach lights with variable brightness control are of value under adverse weather conditions.

Airport Versatility

An airport must be flexible enough to perform manifold functions. It must be capable of handling civil transport of passengers, mail, air express, cargo, etc., on short, intermediate and long hauls. It is desirable that it be able to take care of general aviation. Considerable aviation manufacturing may occur at certain airports, with the resulting test and delivery flights of new aircraft. Joint usage by the military, while not desirable, sometimes becomes a necessity. Military operations normally involve training, air defense and logistics. Finally, necessary provision must be made for helicopter operation.

Various types of operation should be separated as much as possible to prevent cross currents of traffic flow. When aircraft manufacture and test flying occur on a commercial airport they should be divorced from civil air operations Where air traffic is approaching the saturation point, segregation according to aircraft performance or type of operation sometimes offers the possibility of alleviation. Under bad weather conditions, when all traffic must be controlled, an airport runway can safely handle only about 40 landings or take-offs per hour. Intermingling of aircraft with widely varying performance characteristics reduces the acceptance and departure rate of an air terminal.

The Berlin Airlift provided a laboratory for the study of this problem. After attempting to adjust arrivals and departures by mathematical computations, the Air Force found it necessary to remove from the Lift all airplanes whose performance differed substantially from that of the principal type used. In practice this made possible a minimum spacing between arriving and departing airplanes, and assured delivery of a maximum tonnage to Berlin.

The Commission does not feel that segregation should be imposed at airports where it is not immediately needed for the maintenance of necessary traffic flow. Many airports can now accept a variety of aircraft without undue delay. Establishment of full radar control will make it possible to accept aircraft of widely varying performance with much greater facility. In the future, however, municipalities should consider traffic trends and, in anticipation of congestion, make plans for separating (a) fully equipped civil and military transport type aircraft; (b) military reserve training and other tactical military flying; and (c) aircraft with insufficient radio equipment to assure adequate control. Other suitable airports should then be made available.

Airport Accessibility

With the building up of vacant land near airports, airport access roads have become badly congested. As a consequence, a passenger's motor transportation from city-center terminals to the airport is slow and dangerous. To be economically successful, an airport must be reasonably close (in time) to the traffic center it serves. If it is remote, much of the value of air transportation to the public is lost particularly for the shorter hauls.

The great bulk of passenger traffic is short-haul in terms of air time, and as aircraft speeds increase the percentage of ground time in relation to air time will become more and more unfavorable. Figure 4 shows the Time-Distance-Cost of ground transportation from the airport to the city center for 87 typical

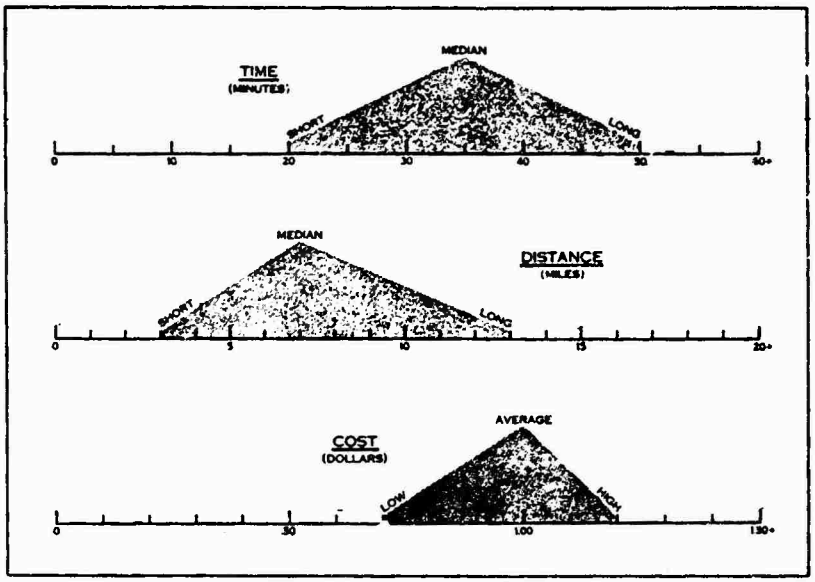

FIGURE 4. A study of time-distance-cost of ground transportation to airports for 87 typical U. S. metropolitan centers.

areas in the United States. The average transit time is 35 minutes; the average distance is 7 miles; and the average cost is $1, from the airport to the city ticket office.

Time, not distance, is the prime factor. Excessive surface transit times result from slow and congested traffic; delay is measured in terms of the number of stop lights one encounters en route to the airport. If average speed can be increased by virtue of clear travel over limited-access highways, time can be cut down considerably; or, alternatively, the airport can be located farther from the city and still retain transit times acceptable to the traveling public. To retain existing passenger acceptance, the airport should not be more than 40 minutes from the city center. For the present, it is believed that the multilane express highway is the best available means of airport access. More such roads are required.

It has been suggested to this Commission that the use of rotary wing aircraft may ultimately overcome the disadvantage of

ground transportation between airports and population centers. Recent studies indicate that the small helicopter will not be economic as an air-taxi. On the other hand, a helicopter of 20-passenger size should, with public acceptance, be able to compete favorably with surface transportation for hauls of 10 miles and upward.

Rotary wing development already is beginning to trace the path of fixed-wing development in aiming at larger multiple-engined craft, able to fly with one engine stopped, capable of lifting heavier pay loads, and necessarily employing larger landing areas.

The Commission believes that flexible provisions for helicopter operations should be incorporated into airport and air traffic pattern planning. Consideration should be given to navigation and traffic control equipment which can cater to the special needs of helicopters.

Airport facilities should be "balanced." That is—air traffic control facilities, runways and ground handling facilities should all be designed to accommodate the same number of schedules per hour and no one airport facility should constitute a "bottle neck."

To date, in transport aviation, the greater part of the effort to save time by air travel has been directed toward increasing the flight speed of the airplane. More thought must be given in airplane design to providing means for saving time in loading and unloading and in the development of airport facilities and procedure to reduce time spent by the passenger on the ground at the airport.

More efficient handling of baggage, prompter ticketing and generally greater operational efficiency at the airport offer possibilities of effecting substantial savings in elapsed trip time and also in reducing congestion at the airport and thus increasing its ground handling capacity.

Ground-time saving is particularly important on short trips

where the airplane does not enjoy the same competitive advantage that it has on longer hauls.

Section 3. The Noise Nuisance

While airports are vital assets of the communities they serve and of the Nation as a whole, they also can be a nuisance to the people who live near them. The principal nuisance factor is noise. As the frequency of flight and the power of the airplanes have increased, adverse public reaction to the noise nuisance has been aroused. Now that most major airports, once remote from urban centers, have become surrounded by residential areas, it is imperative that efforts be made to prevent further increase in aircraft noise and where possible to reduce current noise levels.

The sources of objectionable noise in the neighborhood of airports can be put into two general categories, (1) noise associated with ground operations of aircraft and, (2) noise of flight operations. On airports adjacent to aircraft manufacturing plants, and on those having large airline maintenance and overhaul shops, considerable noise is generated by the running of engines in test stands.

The noise resulting from flight operations occurs during the engine run-up prior to take-off, during take-off, and to a lesser (although still substantial) degree while landing. The principal noisemakers are the piston engine, the propeller, the jet engine, the jet engine with afterburner, the rocket engine and probably the supersonic propeller, in ascending order.

Early studies of aircraft noise were concerned principally with methods of isolating or insulating the occupants of an airplane from noise. While a marked degree of success has been achieved in decreasing cabin noise, progressive increase in aircraft power has greatly increased external noise.

Since 1945 there has been much research into the technical problems of external noise. A recent review by the National Advisory Committee for Aeronautics has detailed the currently recognized nature and sources of objectionable noise, its fre-

quency and intensity. The NACA also has undertaken a research program directed toward finding ways and means to reduce aircraft noise to more acceptable levels.

Previous research by the NACA on the methods and principles involved in quieting propeller-driven piston-engined airplanes has been applied to light airplanes with gratifying results. The possibility of applying these same principles to large aircraft needs further study.

A great potential nuisance is the noise produced by high powered jet engines. Little is known of the manner by which noise is generated in this type of engine. It is believed that the same mechanism that produces the power from these engines also produces the noise. Should this prove true, it will be extremely difficult to effect any sizeable reduction of noise without seriously affecting the propulsive efficiency of the engine. In general this same situation is present in all classes of engines that rely upon a jet for thrust, i. e., turbo-jet with afterburner, ram jet, and rocket.

Considerable effort is being expended by the aircraft industry and the military services to quiet jet engines in test stands, and satisfactory results have been obtained wherever suitable muffling structures could be built.

The problem is more difficult for jet airplane run-ups on the ground. Mufflers have been devised for temporary attachment to single-engine airplanes during ground testing. Potential solutions to the ground-muffling problem for multi-engine jet propelled airplanes are in sight, but it appears that they will be complicated and expensive.

At some airports ground run-up activities have been located where noise will cause the minimum of nuisance. Blast-deflection fences have been built around these areas to divert the noise skyward. In some instances it has been possible to use existing buildings and structures on the airport to serve as baffles. Heavy grass, shrubs and bushes are fair sound absorbers. Some airports have undertaken landscaping programs predicated on this characteristic.

Problems of noise reduction on the ground have not proved easy of solution, but even greater difficulties are posed once an aircraft is airborne. However, there are techniques of engine operation which can minimize landing and take-off noise, and pilots should be required to employ them so far as may be consistent with safe flight practice. Flight patterns can be arranged to minimize noise nuisance.

The urgency of all such efforts is emphasized by the fact that future aircraft power plants will be inherently noisier. The supersonic propeller is a case in point. It has greatly increased performance potentiality, but its noise will be much more objectionable. It may be necessary to limit the use of such propellers near thickly settled areas.

The military services have the aircraft noise problem under consideration by two units of the Research and Development Board, the Panel on Acoustics and its Subpanel on Acoustic Noise Reduction. Much of the work done to date on the ground phases of the noise problem has been accomplished through the Noise Control Committee of the Aircraft Industries Association.

A number of local noise reduction committees have been formed in communities having special problems. A study and advisory group to coordinate efforts on a national scale was formed and held its first meeting on February 2, 1952. It is called the National Aviation Noise Reduction Committee and is a voluntary advisory group composed of government, aviation industry and civic organizations and is sponsored by the CAA. It has a constructive program for noise reduction.

This Commission believes that positive efforts should be continued by both government and industry to reduce or control aircraft noise nuisance to people on the ground and that substantial reduction of such nuisance is practicable.

Section 4. An Analysis of Risk

Absolute safety for the individual is an ideal which has ever been sought but never attained. Because man does not have full

control over his environment, the very function of living has inherent hazards which become more pronounced as the scheme of living grows more complex. Thus, since absolute safety is a theoretical concept, one can speak only of relative safety.

By constantly struggling to reduce the risks which cause accidents, the people of this country enjoy a high degree of individual safety. The trend in total accidental death rates is downward (fig. 5). Relative safety, therefore, has increased. This is true of accidents resulting from natural phenomena, such as tornadoes, as well as those caused by man-made devices, like automobiles, bathtubs—and airplanes.

Trend is not the sole measurement. Relative safety also can be measured by a comparison of the various accident-creating hazards. The 1949 death certificate tabulations by the National Office of Vital Statistics established a priority list of accidents in the United States. Total aircraft accidents (civil plus military) account for a very small part of the death toll caused by the sum of all risks and hazards to which the American public is subjected (fig. 6).

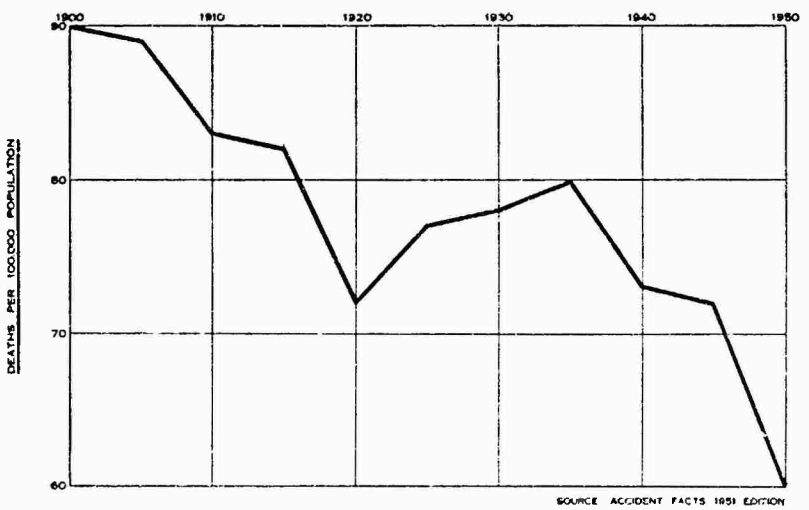

FIGURE 5. In spite of increasing hazards of modern living, the trend of U. S. accidental death rates from all causes is downward.

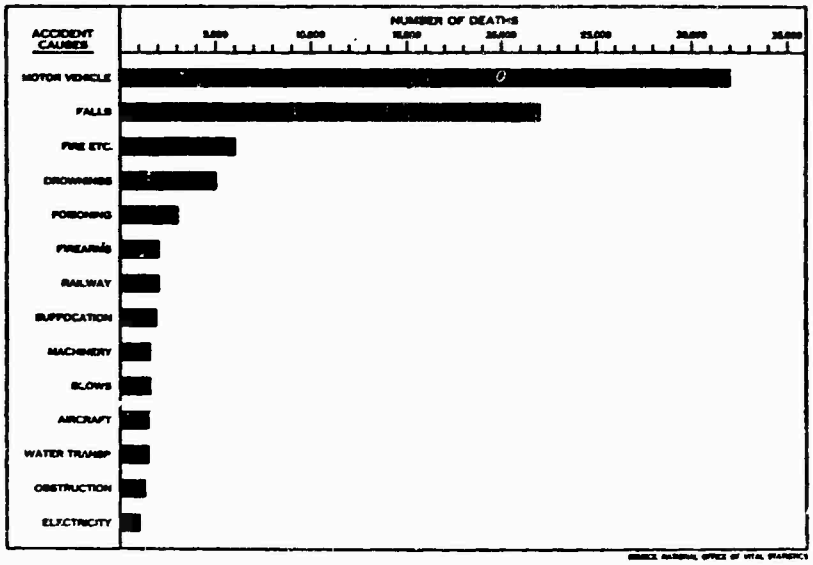

FIGURE 6. In a tabulation of major causes of accidental deaths in the U. S. (1949), aircraft accidents fall close to the bottom of the list.

The "calculated risk" is an American concept which gives mobility to the whole social structure. The phrase simply means a willingness to embark deliberately on a course of action which offers prospective rewards outweighing its estimated dangers. The American public accepts the calculated risk of transportation accidents as an inescapable condition to the enjoyment of life in a mechanical age. However, the public expects and cooperates to obtain a continuing diminution of avoidable accidents so as to narrow the gap between relative and absolute safety.

An airport exists within a community for the use of aircraft supplying the city with services necessary to its welfare. When paths of flight to and from the airport pass over inhabited areas, operations can constitute a potential hazard to people who live or work in the airport approach zones. Similarly, any type of construction in the approach zone represents a potential risk to the aircraft and its occupants on take-off and landing, while tall structures under the airways create a hazard to navigation dangerous both to people in the airplane and on the ground.

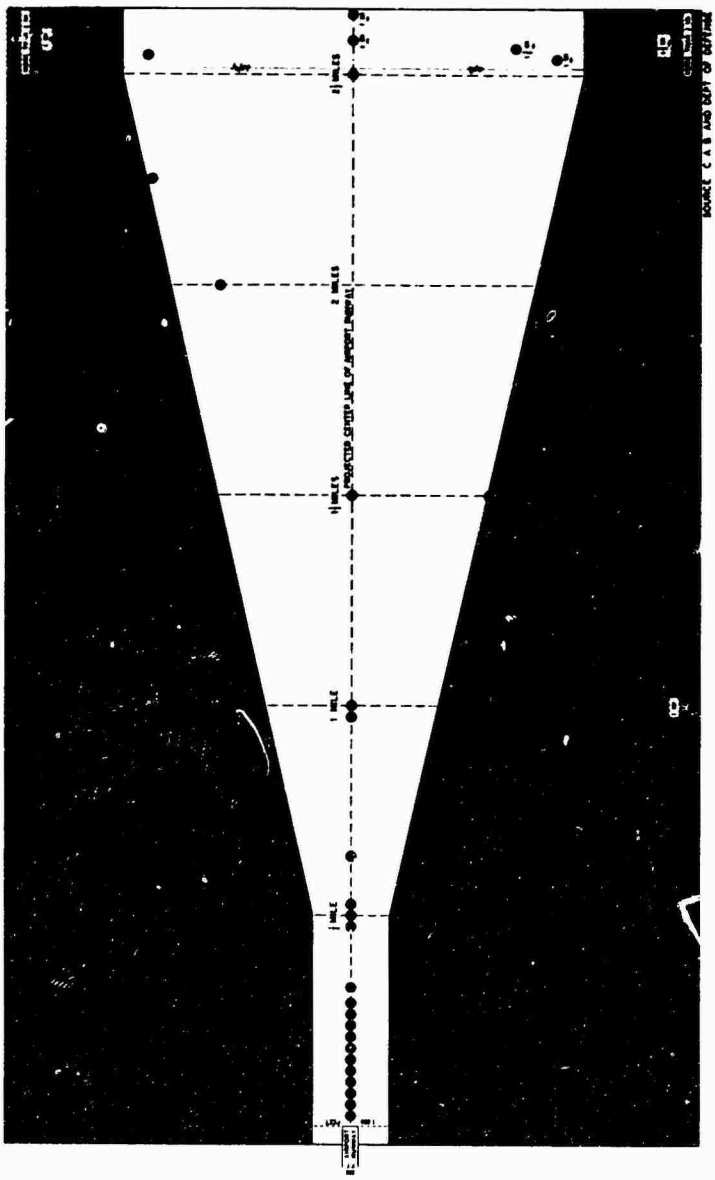

FIGURE 7. This chart shows the relative location of all commercial and military crashes which caused death or injury to persons on the ground near airports during the period 1946–52.

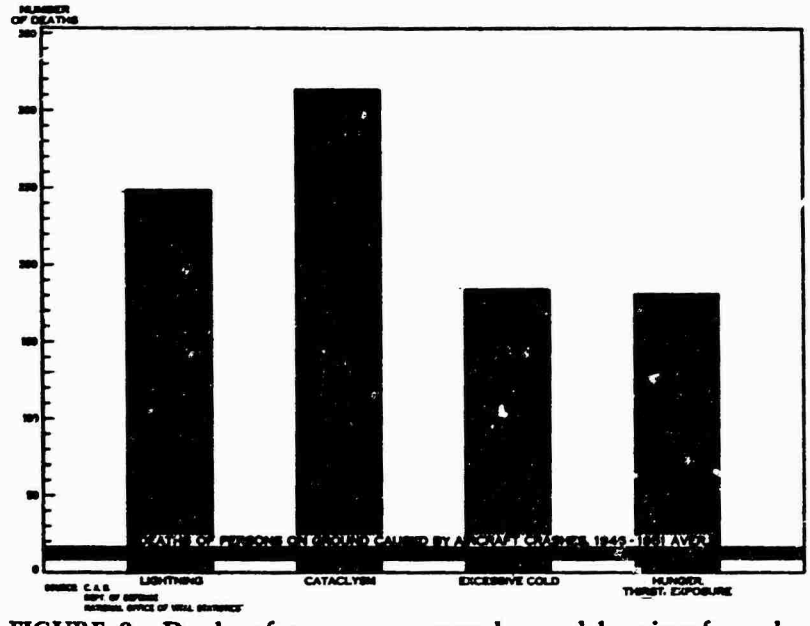

FIGURE 8. Deaths of persons on ground caused by aircraft crashes (1946–1951 average) vs. deaths due to natural phenomena in 1949.

The possibility of an aircraft crashing into one's home is greatest in the narrow, elongated strip of land that underlies the approach zone to runways on airports. Commercial (air carrier) and military airplanes that have caused death or injury to persons on the ground near airports have, in most cases, struck close to the projection of the centerline of the runway and within the approach zone (fig. 7).

Safety measures proposed in other sections of this report certainly will reduce hazard to people on the ground near airports—but even under present conditions the relative hazard is small. Some 570,000 [1] persons in the United States were killed in accidents of all types within the 6-year period, 1946–1951, inclusive. During this time, civil and military crashes caused some 85 [2] fatalities to civilians on the ground near airports. Included

[1] 1946–1949: National Office of Vital Statistics; 1950: Accident Facts, 1951 Edition; 1951: Estimated at 1950 level.

[2] Civil Aeronautics Board; Department of Defense.

in this total were the 19 people killed at the Flagler, Colorado, air show when a stunting airplane crashed into a crowd. Thus, statistically, for every person killed on the ground by airplanes, 6,700 die as the result of other accidental causes.

The 6-year (1946–1951) average for ground fatalities due to airplanes comes to only 15. This figure compares very favorably with deaths caused by some of the less common accidents. In 1949, cataclysm, lightning, excessive cold and hunger-thirst-exposure each caused significantly more deaths in *one* year than aircraft crashes did in 6 years to persons on the ground near airports. This is indicated in figure 8.

Because of the nature of transportation statistics, comparisons of the safety records of various modes of transportation do not yield the complete answer. Historically, safety in transportation has been measured by the passenger fatality rate per 100 million passenger-miles. This system was developed first by railroads

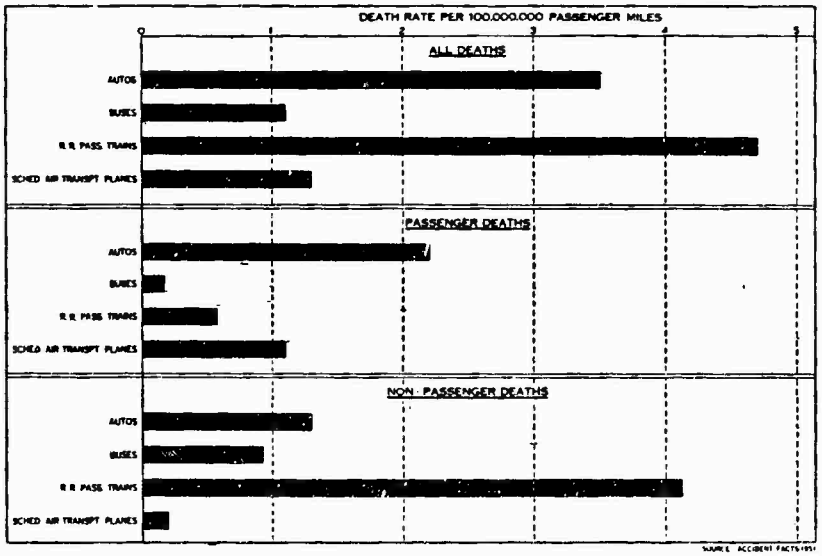

FIGURE 9. A comparison of accidental death rates for common U. S. transport vehicles for 1950. Fatal accidents to innocent bystanders are shown in the lower part of the chart. (Buses—intercity only.)

and succeeding forms of transportation established a similar index in order to have comparability.

Scheduled air transportation showed a total passenger death rate of 1.1 per 100,000,000 passenger-miles in 1950. This was 50 percent below that for passenger automobiles and approximately twice as great as for railroad passenger trains. However, when the fatalities to pedestrians, people on the ground, trespassers and others are added in each category, the comparative position of air transportation is greatly improved. In 1950, the 1.3 "all-death" rate per 100,000,000 miles for scheduled air transport was 60 percent below that for passenger automobiles and less than one-third of the rate for railroad passenger trains (fig. 9).

The figures set forth in the table below emphasize an obvious but important fact about aviation fatalities. By far the greater number of fatalities occur to passengers in the airplane rather than to persons on the ground near airports. Even bicycles kill more innocent bystanders annually than airplanes. In 1949, 17 persons were killed by bicycles against 15 (annual average 1946–1951) on the ground by aircraft.

TRANSPORTATION ACCIDENT DEATHS AND DEATH RATES: 1950

Kind of transportation	Millions of passenger-miles	Deaths		
		Passenger	Non-passenger	Total
Passenger autos and taxis	810,000	17,600	10,400	28,000
Buses—Intercity	59,000	100	570	670
Railroad passenger trains	31,800	184	1,311	1,495
Scheduled air transport planes	8,363	96	15	111

Source: Accident Facts, 1951 Edition, page 77.

Scheduled and non-scheduled airlines made 20,724,961 landings and take-offs at airports with CAA traffic control towers

for the years 1946–1951, inclusive. The total landings and take-offs of aircraft operated by scheduled and non-scheduled airlines within the continental United States for this period can be conservatively estimated at 26,000,000. A figure of 28,000,000 will also include the first four months of 1952.

In 1946–1951 there were approximately 6,500,000 landings and take-offs by aircraft of scheduled and non-scheduled airlines for each crash claiming the lives of people on the ground who were not occupants of an airplane. Inclusion of the three fatal 1952 crashes within the New York-Northeastern New Jersey Metropolitan Area reduces this ratio to 4,000,000. Despite the unusual concentration of crashes in that locality early in 1952, the probability for this type of accident happening was and still remains remote.

Part IV

THE AIRPORT AS A NATIONAL PROBLEM

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Part IV. The Airport as a National Problem

Section 1. Some Mechanical and Human Factors

In the final analysis the direct sources of hazard to people on the ground are the airplane and the crew who fly it. If one or the other fails, a crash may result. Anything, therefore, that makes the machine more reliable, or the crew less subject to failures contributes to the safety of people on the ground.

For a good many years aviation has been a carefully regulated business. The potential danger to passengers in airplanes provided sufficient stimulus to create this regulation. Few, if any, industries function under such stringent laws and inspection systems. Certainly no other transportation medium is so completely supervised.

From the original design stages an airplane must conform to government specifications. A civil transport airplane, for example, must take off in a certain maximum distance, climb at a certain rate, land and stop within a specified distance. It must be capable of flying with one or more of its engines stopped. It must incorporate hundreds of safety features such as fire-detection systems, emergency exits and automatic controls, or it will never be allowed to carry passengers. The specifications are so exacting as to rule out the possibility of an unproved or dangerous civil transport being put into airline service.

A new aircraft is inspected in detail throughout its manufacture. Before it is licensed, it must demonstrate its ability to perform in accordance with specifications in extensive flight tests. Even after the aircraft is licensed, the industry voluntarily puts it through an extensive shake-down period (carrying cargo and mail) before it is released to carry passengers.

Once the airplane is in everyday use it must be maintained in accordance with other detailed regulations. The overhaul and servicing manuals for an average airliner make up a good sized library. The mechanics who service civil airliners must be certified for competence by the Civil Aeronautics Administration. Transport airplanes are checked before every trip and are thoroughly inspected and overhauled in accordance with a detailed schedule based on flying hours. The modern airplane, for all its complexity, has greater mechanical integrity and reliability than any other modern vehicle. But this does not mean that the possibilities for greater safety have been exhausted.

Mechanical Improvements

The airplane designer cannot dissociate himself from the problem. He is, after all, the creator of the dynamic half of the airplane-airport combination. As the airplane becomes more nearly "foolproof" everyone will benefit.

One important design objective is to minimize the effect of possible mechanical failures. A short circuit in the propeller control, for example, must not start a chain reaction which will result in the propeller suddenly reversing in flight. Designers must anticipate the results of failure of any system or component and must provide for such contingency in a way that will not jeopardize the aircraft's ability to continue flight. This is known as the "fail-safe" theory of design. The Commission feels it should be applied to all critical aircraft systems.

Carrying this concept of safe failures to its logical end requires that the designer also anticipate the infrequent lapses of the crew. Despite the many items which the crew must check before take-off or landing, only a relative few are likely, by their omission, to cause a crash. On airplanes flown by most major airlines, some of these critical systems are interconnected to make crew lapses improbable—for example, a pilot cannot advance his throttles to take-off power until he has unlocked his controls. The Com-

mission believes both airlines and airplane builders should extend such "human fail-safe" measures wherever possible.

The designer has still another obligation. For the benefit of the crew, he must reduce the complexity of the modern aircraft and its associated equipment. Literally hundreds of instruments, switches and knobs have replaced the relatively simple control mechanisms in airplane cockpits of a few years ago. Unfortunately, human capability has not increased as rapidly as mechanical complexity. A design objective should be the maximum use of "fail-safe" automatic devices which will relieve the crew of routine responsibility for many aircraft functions.

Crew Selection

The crew of a present-day airplane is selected with great care and subjected to stringent medical examinations. This is particularly true of the pilot who is both airplane captain and the man at the controls. His two most important qualifications are professional competence and judgment. Lack of either characteristic in a pilot could lead to serious difficulty.

Professional competence in a transport pilot is a definable combination of many things: knowledge of the airplane itself; highly developed flying ability; good coordination; excellent eyesight, good hearing, and generally good health. Judgment, on the other hand, is an intangible. A pilot acquires judgment in direct ratio to his experience. All things being equal, the older the pilot the better his judgment. This build-up continues for many years. Ultimately, however, a point will be reached where age slows a pilot's reflexes and begins to offset his accumulated experience and judgment.

Because the airline industry is young, few pilots have yet reached the point of diminishing capabilities. In the next decade, however, airlines will have to give serious consideration to the proper utilization of older pilots. At the point where a pilot's experience no longer compensates for his reduced physical capability, airline captains should graduate to a recognized senior

status, be assigned to other duty, or retire. As an example, some might be put in command of the largest and fastest transports on routes requiring the most experience and judgment. In this case a fully qualified first pilot or reserve captain should handle the controls.

At present, airline pilots are required to undergo semiannual physical examinations. Specifications are set by the CAB and CAA, but the examinations given by most major airlines are actually more searching than regulations require. While this system is somewhat less severe than that of the military services, it has proved adequate until now. The Commission feels, however, that it should be stiffened in the future because of the pilot age problem. A thorough study of pilot aging and allied problems should be sponsored by the Aero-medical Association.

Inspection

The Civil Air Regulations, in general, provide a sound basis for the safe and efficient supervision of civil aviation. CAA inspectors are constantly checking airline operators, personnel and equipment for compliance with the rules. All airlines are required to give their pilots periodic checks in compliance with the Civil Air Regulations, but the CAA is now able to participate in only a part of these checks. Thus, day to day inspections and checks must be largely left up to private industry. Industry has discharged this obligation conscientiously and effectively in most cases but the CAA should have a more direct knowledge of the condition of the crews and equipment in the commercial air transport industry than is now possible. It is believed that the number of CAA inspectors should be raised.

The increasing speed of aircraft, coupled with the steady expansion of air traffic, puts an ever-increasing premium on instrument-flying proficiency. Most airlines and the military have in the past put great emphasis on training in instrument techniques but the Commission feels that an enlarged instrument flight training program is desirable. Pilot checks, to be more effective, should be given in simulated weather and traffic conditions.

At the same time, the Commission recognizes that the increasing complexity and operating cost of present-day airplanes have reduced the opportunity to practice procedures for flight emergencies. Crashes on take-off or on landing approaches are usually the result of a sudden variation in normal conditions, brought on either by mechanical failure, weather phenomena, or by both. An inadequately trained crew is faced with a problem for which it has no immediate answer. When an airplane is close to the ground, there is never any time for consultation or reflective thought—only for reflex action. The unrehearsed emergency sometimes may end in a crash. Such crashes after take-off or just before landing are always near airports. Any action, therefore, which reduces such crashes lessens the danger to people on the ground.

The CAA is the designated government agency for the inspection and technical supervision of commercial aviation. This inspection includes the checking of flight crews. For obvious reasons this checking of flight crews is done in the airplanes of the various airlines. A few years ago the Douglas DC-3 was almost standard equipment on U. S. airlines, with some Lockheed Lodestars and a very few other types. CAA inspectors were themselves well-qualified in the DC-3. It is, compared to a modern multi-engine transport, a fairly simple and relatively slow machine. A check by a CAA inspector in this type of airplane was a thorough examination by a fully qualified examiner.

Now the picture has changed. CAA inspectors find it impossible to be qualified in all the airplanes in the growing list of new air transports. Instead of a single basic airliner, the DC-3, we now have in widespread use some 10 basic types ranging in weight from the DC-3 to the Stratocruiser. Obviously, the CAA flight inspectors cannot become and remain proficient in each of these types of aircraft.

Electronic flight simulators offer a practical solution to this problem. Simulators for each type of commercial air transport should be made generally available. These should be purchased

by industry, with the airlines acting individually or in concert, and they should be accessible to all transport companies on a fair rental basis. If industry does not discharge this responsibility, consideration should then be given to having simulators furnished and operated by the CAA. As new transports are built, new simulators should be provided to match them.

Synthetic Training

A flight simulator cockpit is an exact replica of the cockpit found in the corresponding aircraft. All controls and instruments are where they would be in the real airplane. A complex system of electronic amplifiers, computers, and servo-mechanisms creates in the cockpit mathematically correct response to any application of the controls. In other words, except for acceleration, the simulator behaves like the airplane under any given set of conditions. Sound effects, including the noise of the engines, complete the effect of realism. With this advanced device it is possible to drill a crew in emergencies too hazardous to create deliberately in an actual airplane. Air crews, when faced with these emergencies, will occasionally "crash" in the simulator—just as they would have crashed in the airplane. But in this instance they can study their errors, and practice again and again until their responses are as automatic as that of a good automobile driver. Emergency drill thus becomes a systematic and carefully planned routine.

The initial installation cost of ten simulators, located in a single building at a central point, would at present prices be about $5 million. This would include the simulators themselves, at approximately $400,000 each and a building to house them, at $600,000. The average annual operating cost including salaries, utilities, maintenance and depreciation, should be on the order of $500,000 annually. The program should, in time, become self-supporting. Its early establishment is essential to safety.

The Navy and Air Force have spent very large sums for flight

simulators. They expect, in return, to develop more highly trained crews, skilled in the handling of emergencies, at a much lower total training cost. Most importantly, the services expect a reduced accident rate particularly for those emergencies possible to practice only in the simulator.

One airline has long since proved to its own satisfaction the sound economics of the flight simulator. For example, the cost per hour of training in a Stratocruiser is $450: in the flight simulator for this airplane it is, at normal utilization of the simulator, $12.48 per hour. In addition large scale use of simulators would decrease substantially (although it would not eliminate) the amount of required local flying training with a proportionate decrease in the noise and hazard which goes with such flying. The principal argument for the simulator as an aid to airport safety, however, lies in its potential ability to prevent the type of crash stemming from a take-off or landing emergency.

The electronic flight simulator offers an available and immediate solution to some safety problems; as a long-range corollary, a program to standardize the cockpits of transport airplanes should be pressed. Such a program ultimately will reduce the number of simulators needed. It also will implement the Commission's recommendations for simplification of aircraft design and will increase flexibility of operations without compromising safety. As we have noted, pilots are subject to human lapses; if the airplane a pilot is flying on a given day has a flap-handle where the gear-handle was in another airplane the day before, or the feathering switch has moved from place to place, instinctive reactions in emergencies may have unfortunate results. The standardization of flight instrument panels would remove this hazard and would insure the best use of a pilot's experience as he shifts from one transport to another.

Section 2. Air Traffic Control

A system of aerial highways called "federal airways" connects all major cities in the United States. These airways are marked

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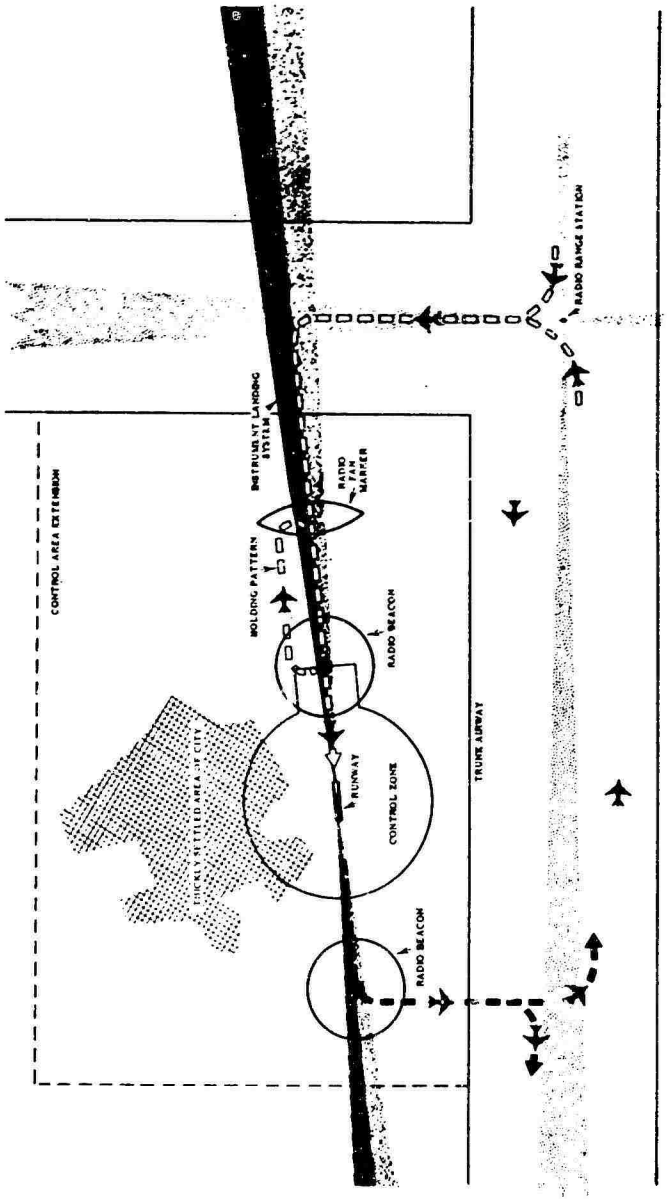

FIGURE 10. A possible arrangement of airport, airways, and a metropolitan center. The approaches and the holding patterns are planned to avoid low flight over thickly settled areas. The minimum navigational and air traffic control installations are shown.

with electronic navigational aids (beams, beacons or modern omniranges) designed to transmit signals to aiplanes which will enable them to keep on their proper course and know their position as they fly.

Airways go from point to point with little by-passing of metropolitan areas. For example, a pilot who wishes to follow the main airway from Washington to Philadelphia must go directly over Baltimore. The same thing is true of a plane flying the standard low and medium frequency airway from New York to Chicago; it must pass over Youngstown, Cleveland, and Toledo, among other cities, instead of moving directly between these two major points. However, on long non-stop flights which are normally flown at very high altitudes, it is now customary to take a direct or nearly direct track and to avoid flying over intermediate points.

Most through traffic is high enough to cause no noise nuisance to the population below. However, with increased traffic and with increasing public concern over the nuisance and occasional hazard of overhead air traffic, there is now reason to examine the case for relocating some airways facilities to avoid congestion and to reduce flying over thickly settled areas. Moving an airway is a practical thing, involving little construction. Costs are low compared to the re-routing of a highway on the ground. This may be accomplished by establishing a controlled zone around the metropolitan area which would be entered only by aircraft arriving at or departing from the local airport or airports. All aircraft not destined for that particular area would be obliged to by-pass the restricted zone en route to their destination.

The routes established within the restricted zones should be used in all weather conditions. They would become as well fixed, almost, as roads on the ground and pilots would develop the habit of following the established pattern. One possible arrangement is shown in figure 10.

During instrument weather, aircraft awaiting take-off are delayed at times by landing traffic and must sit on the ground

awaiting take-off clearance for long periods. Aircraft flying a "holding" course, waiting for clearance to land, are normally held in areas close to the airport. Where such holding patterns must be on airways, through traffic is assigned higher altitudes. Although holding patterns now cover less area than several years ago, it is still desirable to separate all airways from holding patterns. A program to provide through, express airways between major points that would by-pass thickly settled areas is essential if increased air traffic is not to result in increased nuisance and increased delays.

Holding patterns should be located over thinly settled areas wherever possible and should be well separated from through airways. Full radar control in terminal areas offers the best known means of reducing aircraft time in holding patterns to a minimum while increasing total traffic which can be safely handled. Straight-in approaches are the safest and best. Such approaches avoid circling and maneuvering at low altitudes in the vicinity of airports thus reducing both nuisance and hazard. It is believed that minimums for straight-in approaches now established are satisfactory but that maneuvering under low overcasts over thickly populated areas should be reduced and that circling minimums in critical areas should be raised. With radar in full operation this could be done without decreasing the number of IFR landings possible in a given time. The Commission believes that application of positive radar control to civil aircraft operations in terminal areas should be accelerated. Surveillance radars make approaches and departures in low visibility simpler and safer. At some major airports final approach to the instrument runway can be made either with ILS or GCA. It is believed that both should be available at all major airports. Where both ILS and GCA are available, pilots should be required to use them both, one as the primary landing aid and the other as a monitor.

Eventually, with the development of improved position indication within the airplane and the tying-in of radio signals with

the auto pilot in order to permit completely automatic landings, the airborne equipment will control the airplane under the supervision of the pilot who will have ground radar information with which to monitor his approach continuously.

Adequate ground radar is essential for the proper controlled separation of airplanes in congested areas. Properly utilized, it will serve to prevent mid-air collisions within its range. Away from the airport precise traffic control is more difficult. Eventually, the airplanes themselves should have some form of light and reliable airborne radar to guard against mid-air collisions en route, to give warning to the pilot of the presence of mountains or other ground obstructions and to avoid thunderstorms and other conditions of excessive air turbulence.

Full use should be made of recording instruments, both in the airplane and on the ground in order to obtain as much information as possible on emergencies in flight. These instruments would also monitor compliance with regulations and good practice and act as a further stimulus to safe and sound operations.

Airways operation—the function of communicating with and directing aircraft in flight to specific altitudes and over fixed airways—is one of the principal functions of the CAA. In the past the prime and practically the only objective of Air Traffic Control has been to maintain a flow of airplanes in bad weather in such a way as to prevent their colliding with one another. In weather where the visibility is more than three miles and the ceiling is over 1,000 feet, airplanes may fly on airways without supervision so long as they stay out of the clouds. Avoidance of thickly populated sections when above minimum altitudes is not required by Civil Air Regulations. In the case of the Navy, the Air Force, and some individual airlines, policy directives of the operating organizations require avoidance of flight over major cities. Municipalities have, in some instances, passed ordinances forbidding flights below certain altitudes and over certain areas. Without radar, two-way radio, and the other equipment necessary for Air Traffic Control it is extremely diffi-

cult either to detect violations of, or enforce, these ordinances. It is impractical for a city to attempt to get into the air traffic control business. Unified Federal control of all air traffic is a basic principle of the Common System of national airways. It has been authorized by the Congress and must be used by all aircraft, military and civil.

As now written, the Civil Air Regulations permit uncontrolled VFR flights in relatively low ceilings and visibilities, even in congested areas. These regulations were written at a time when aircraft were a great deal slower and more maneuverable and visibility from the cockpit was better. Present-day airplanes have made uncontrolled traffic in highly congested areas unwise. In areas where there are approximately 100,000 or more aircraft operations per year, all traffic should be under positive control—regardless of the weather—when in designated control zones. In less congested terminal areas and possibly along airways, the minimum visibility and ceilings at which traffic is free to fly uncontrolled should be raised.

The recommended tightening of airway and traffic control regulations would solve two other problems. First of all, it would help to move instrument flight training (including the 6-month flight checks of airline crews) into less congested areas where much of it properly belongs. Second, it would go a long way toward eliminating mid-air collisions, either en route or over terminal areas. Since 1946 there have been 160 mid-air collisions each of which involved at least one civil aircraft. All but one of these occurred at a time when air traffic was not under positive control.

Early installation of omnirange and distance measuring equipment in all aircraft flying under instrument conditions would simplify the en route and terminal area traffic control problems and would improve safety as well as reduce delays in congested areas. Such installations would also permit early retirement of obsolete four-course LM/F ranges and would reduce the necessity for relocation of such outmoded aids.

Section 3. Some Legal Aspects

Because the Commission had no legal staff of its own, the services of several well-qualified consultants were obtained on matters of law relating to airports and the use of the navigable airspace. These individuals and organizations are listed in section 1 of the Appendix. The legal departments of both the Civil Aeronautics Board and Civil Aeronautics Administration were also consulted during the study.

The findings of the legal advisors have been incorporated in various parts of this report. This section is a condensation of a legal opinion developed for the Commission by Pogue & Neal under the title "The Legal Framework of Airport Operations." (This opinion was examined by John C. Cooper, another of the Commission's legal consultants, who concurs in and approves the general principles stated.) It deals with three basic problems: (1) the conflicting claims between property owners and airports; (2) the scope of a State's authority (direct or delegated) to foster airport growth; and (3) the scope of the power of the Federal Government with respect to airport location and regulation.

Since aviation law is a relatively new element in American jurisprudence, it is not surprising that certain matters under these headings have not been covered by judicial decision or by legislation. Indeed, some of them have led to conflicting decisions in the lower courts and are now awaiting resolution by the Supreme Court, or by legislative action.

Airport Operator vs. Landowners

In problems involving disputes between landowners and airports, the courts have considered their function as one of balancing equities based on the facts of each individual situation. In some cases, particularly earlier ones, they went so far as to close down some airports completely by enjoining them as a nuisance. In more recent decisions, however, a more sympathetic view has been taken towards airport operations. Courts have often issued

injunctions requiring take-offs and landings to be made above a certain altitude over the objecting landowner's property. But in many recent cases, they have refused to issue any injunction whatever on facts where earlier they would surely have done so.

The other aspect of the problem involves suits by airports against landowners alleging activities which hamper airport operation. If an alleged obstruction is clearly a "spite" construction, e. g., tall poles of no value except as they will prevent airplanes from flying low, the courts have not been sympathetic to the landowner. It then appears that the landowner is trying to force the airport to purchase his property. Courts have either required the removal of such obstructions or limited their height. Involved in each decision, of course, is a basic analysis of the rights of the landowner, and the same "balance" of equities takes place.

When the obstruction is a legitimate one, such as power lines or a water tower, the courts have been more sympathetic, particularly if a "private" airport not involving extensive interstate commerce is involved. If there is conflicting testimony as to whether the construction is really an obstruction, or if the airport was negligent in not protesting the building until after it had been completed, the landowner's side of the scale is additionally weighted. Finally, if it really appears that the construction is an obstruction, but a legitimate one, in the absence of prior enacted zoning laws the court will hold that to require the landowner to remove the obstruction would be a "taking" of property which can only be accomplished through the legitimate use of the power of eminent domain with due compensation to the landowner.

State Authority Over Airports

The question of whether a State, municipality, or public body created by a State has the authority to acquire, maintain, and operate public airports is a matter of the interpretation of specific State statutes or constitutions. In early years taxpayers unsuc-

cessfully sought to restrain the use of public funds for the acquisition of airports on the grounds that an airport was not a "public purpose" or "public utility."

Having passed that hurdle, the next obstacle was relatively simple. Eminent domain is a power which naturally flows from the police power possessed by the several States and its exercise is one which, as stated in State constitutions, may be exercised when property is needed for the "public use." It was not long before the courts had sustained the action of States and municipalities and of public corporations and airline companies if properly authorized under State legislation, in utilizing the power of eminent domain to acquire land to construct an airport as one for "public use." The authority of the State to employ the power of eminent domain to acquire land for an airport to be constructed by the Federal Government has also been sustained.

An airport which is owned by a State or other public body is definitely in the "public interest." But it is clear also that although a given airport be deemed in the public interest, it does not follow that individuals or corporations using the airport for their own benefit may deprive the adjacent landowners of their enjoyment of property. It would further appear that the political subdivision of the State which operates the airport is not immune from liability by way of damage or injunction. No legislature can confer immunity from action for a private nuisance of such a character as to amount in effect to the "taking" of private property for public use.

The most important question relating to States, however, concerns zoning. An airport costing many millions of dollars—an essential element in interstate commerce, the postal service, and the national defense—may be made worthless if the surrounding area is allowed to build up to obstruct its clear approaches.

The power to zone, although a relatively recent development, is an undisputed exercise of a State's police power. As far as a municipality or other public body is concerned, however, it must receive specific authority from State legislation in order to do so.

At least 35 States now have a statute (most of which are similar to the model statute drafted by the National Institute of Municipal Law Officers and the CAA) authorizing the adoption of zoning ordinances.

The power to zone, however, is a limited one. It must not be unreasonable or open to charges of discrimination or uncertainty. Of primary importance, however, is the fact that it cannot go beyond the line of regulation and become an actual "taking" of property without just compensation. Zoning, of course, as with any other exercise of police power, takes away some rights incident to the property in the public interest. If zoning attempts to deprive the landowner of a substantial interest in his property under the pretense of regulation, however, and results in a substantial diminution of property values, then it becomes a "taking" without due process of law, and if the State or public body desires the property it must utilize its power of eminent domain. The facts of the particular case determine when this line is reached. It also would appear evident that while any State action settling a "navigable zone" for aircraft approaching an airfield could be justified on the broader ground of benefit to the community as a whole, it also might be considered a "taking" which could only be accomplished through eminent domain if, in fact, it resulted in a substantial diminution of value of the land.

Accordingly, zoning is best when it has no retroactive effect, and only limits development which *might* occur in the future as opposed to development which already exists or is on its way. Zoning insofar as it applies to already populated areas immediately raises the problem of whether or not it is a "taking."

Scope of Power of Federal Government

There is no existing legislation which would authorize the Federal Government to zone areas around airports. There is reason to believe, however, that the Federal Government, as a corollary to its authority to regulate interstate commerce, and

under its postal and national defense powers, has the power to regulate and to zone any airport engaged in such activities.

There are two basic issues involved in a discussion of the Federal power to zone areas around airports; namely, (a) the scope of the power to zone and (b) the extent to which zoning requires compensation to private landowners.

It appears that unquestionably the Federal Government has the authority, through appropriate legislation, to control the height of structures or natural objects in an area surrounding an airport to protect interstate air navigation. It has been held that the Federal Government could utilize the power of eminent domain to acquire land for an airport since the construction of airports is a legitimate exercise of the constitutional power to regulate interstate commerce. It would follow that it has the power to zone to protect approaches to the airport, or otherwise its power to build airports is rendered ineffectual. Similarly, if the Federal Government has the power to control interstate air navigation through the promulgation of rules of flight, etc., its power to zone around existing airports not owned by the Federal Government would seem equally to follow because rules of flight will not foster the development of interstate air navigation if obstructions can prevent the operation of such rules. Recent decisions of the Supreme Court which have recognized the broad sweep of the power of the Congress to regulate interstate commerce would support this conclusion. Vertical zoning once authorized by Congress and effectuated by a Federal administrative agency would supersede and preclude State zoning of the same area.

A much more difficult problem, however, concerns the power to zone an area surrounding an airport in order to prevent it from developing into a residential area. Since the primary focus here is on the protection of citizens residing near airports, zoning legislation would seem to fall more appropriately within the field of the State police power. From the standpoint of the Federal Government such "horizontal" zoning is not as clearly

connected with the regulation of interstate commerce as the restriction of the heights of buildings, except in an anticipatory manner. However, the Supreme Court has gone to such extreme in validating congressional legislation pursuant to the power of the Congress to regulate commerce that there appears to be a reasonably good chance that zoning power of this nature might be upheld.

Compensating Landowners

The question involved in any exercise of the power to zone either by the States now, or by the Federal Government at some future time, is when does the diminution of property values become such that it is a "taking" for which the property owner must be compensated under the Fifth Amendment?

In the field of Federal regulation the Supreme Court has often declared that the utilization of the power to regulate interstate commerce or to provide for the national defense has a limitation in that it cannot extend so far as to comprise a "taking."

Unfortunately, the question when an application of the Federal Zoning Statute would result either (1) in non-compensable diminution in property values; or (2) to a compensable "taking" depends so much on the facts of the case that it is impossible to spell out the line clearly. The "balance" will always be one between public and private interest as set forth in the many zoning cases brought up under the Fourteenth Amendment. The monetary value of the private investment is important, e.g., how much is the value of the property diminished? This may be partially outweighed, but never completely so, by the public interest involved.

The area in which zoning is much more apt to be a "taking" is, of course, where there are established structures and businesses which will be destroyed. It is less apt to be a "taking" when merely the future use of property will be restricted.

Any Federal Zoning Act should include a provision whereby a landowner who alleges that he has been aggrieved may have

an opportunity to have his grievance heard and adjudged. Otherwise, the statute may be struck down as a violation of the Fifth Amendment to the Federal Constitution.

Zoning of Airport Approaches

It is safe to say that the Congress has the authority, pursuant to its power to regulate interstate commerce, to provide for the regulation of airport approaches utilized by aircraft in interstate air navigation to the exclusion of any local regulation by the several States.

When this issue comes before the Supreme Court for decision, it is expected that it will hold that since any aircraft at large in instrument weather (which may close in with unpredictable suddenness) is a hazard to all interstate commerce, the Federal Government may pre-empt this entire field of safety regulation.

Section 601 (a) (7) of the Civil Aeronautics Act of 1938 authorizes the Board to promulgate "air traffic rules governing the flight of, and for the navigation, protection . . . of aircraft, including rules as to safe altitudes of flight and rules for the prevention of collisions between aircraft, and between aircraft and land or water vehicles."

Pursuant to this congressional mandate, it is clear that the CAB or the CAA could determine traffic patterns into and out of any airport in the country for any aircraft engaged in interstate, foreign, or overseas air transportation.

The power of the CAB and the CAA to regulate airport approaches under the Civil Aeronautics Act has not been exhausted. Under existing law it can prescribe air traffic patterns which will supersede all other air traffic patterns.

The only limit to the exercise of this authority is, as in the case of zoning, the point where regulation may so affect the value of the property owners beneath the airport approach pattern that it constitutes a compensable "taking." In such instances, eminent domain must be utilized either to acquire title to the land below, or, at least, to acquire an easement through the airspace.

Use of Airspace

The Civil Aeronautics Act provides any citizen of the United States a "public right of transit in air commerce through the navigable airspace of the United States" and further defines "navigable airspace" as airspace above the minimum safe altitudes of flight prescribed under the Act.

In Part 60.17 of the Civil Air Regulations, the CAB has set forth certain "minimum safe altitudes." It is there noted that "except when necessary for take-off or landing" no person shall operate an aircraft below the specified altitudes. Thus certain altitudes are required over "congested" areas while others are required over "other than congested areas." It is doubtful, however, whether the CAB in determining these altitutes was considering the effect which they would have upon the determination of "navigable airspace" as defined by the Act. Rather, it would seem the CAB was simply concerned with safety as evidenced by the fact that the "minimum safe altitude" in case of a power failure is one which will allow an emergency landing without undue hazard to persons or property on the surface. This situation casts considerable confusion into the determination of what is "navigable airspace."

In view of the fact that the question of the extent of private ownership of "airspace", on the one hand, and the necessity of compensating the owner of the land beneath if ultimately it is found that his property is "taken", whether by zoning or by the imposition of regulations, on the other hand, it seems unnecessary to consider further the troublesome problem of the extent of "airspace" ownership. The important point is that means must be provided to permit the adjudication of any claims of "taking" from whatever source the "taking" arises. Otherwise, the act resulting in the "taking" could probably be enjoined.

The CAB now has authority from the Congress to regulate and determine airport approaches, some of which it has delegated to the CAA. Accordingly, all that needs be done is as follows: (a) the best airport approach pattern for a particular airport

can be determined; (b) if it appears that that airport pattern depreciates property values of underlying landowners, the power of eminent domain can then be exercised to acquire title to the land or an easement through the airspace. The CAA now has the authority within the limit of congressional appropriations to acquire land needed for such purposes, and in the case of air-navigation facilities (including airports) owned by the United States and operated by the CAA, to acquire easements through or other interests in airspace at a price which takes into consideration reasonable probable future use of the underlying land (section 302 (c) of the Civil Aeronautics Act of 1938). This statutory authority should be extended to authorize the condemnation of easements through the airspace surrounding airports not owned by the United States.

The Power to Regulate the Use of Airports

There is no existing legislation which would authorize the CAB to exercise the kind of direct regulatory power over an airport which would, for example, confer power to determine when it should be opened or closed. It appears that the Federal Government could, through appropriate legislation establishing standards for regulatory action appropriately related to Federal powers over interstate commerce, the postal service, and national defense occupy for itself the power to regulate airports under those standards, including the power to open and close them. Under such legislation, it is clear that the Federal Government could act appropriately where buildings and natural obstructions surrounding an airport endanger the airport's approach patterns to such an extent as to endanger interstate air navigation utilizing the airport. Whether such legislation could exclude the exercise by States and municipalities of their police power with respect to airports can only be finally determined by judicial decision. However, any such Federal legislation should make it clear that the intent of the legislation is for the Federal Government to occupy the field exclusively so far as legally pos-

sible. The scope of the constitutional authority which would embrace such power has been explored above.

Airports are vital and integral parts of any interstate air transportation pattern which the Congress, through its power to regulate interstate commerce, can control. Accordingly, constitutional principles appear to support congressional authority to authorize the CAB or the CAA to grant "certificates" to airport operators whose standards meet those prescribed as being consistent with the protection of interstate air transportation. Similarly, the power to suspend, to revoke, and to regulate abandonment of those "certificates" could be placed within the purview of the CAB's authority on the grounds that it is necessary to protect the interstate air transportation using such airports.

Part V

THE AIRPORT IN THE COMMUNITY PLAN

Part V. The Airport in the Community Plan

The general objective of all communities is to create a favorable environment in which to live. Experience has shown that this environment does not just happen; there is a genuine need to control the forces which determine environment. Planning is a tool for bringing about an effective control of the forces. It does this by creating a physical framework in which communities may eventually achieve a desired environment. The framework is erected by: (1) allocating areas to industrial, commercial, and residential uses; and (2) establishing physical facilities to serve these areas; i. e., transportation, communications, power, water and sanitation, and recreation grounds. Since airports and airways are an important part of a community's transportation facilities, consideration must be given to the problem of properly incorporating them into the framework.

While many urban airports have been comprehensively planned from the standpoint of air transport and aircraft requirements, insufficient attention has been given to their physical relationship to the urbanized areas of which they are a part. Little attempt has been made to discuss future development with local officials and citizen groups to assure conformity with local plans and programs. If the comprehensive planning procedures outlined later in this section are followed, the Commission believes much of the opposition to airports will be averted.

More than half of the Nation's population now lives in 168 metropolitan regions, as defined by the U. S. Census. The number and size of these regions are increasing at a rapid rate. In 1940, 57 of the census' metropolitan regions had a population over 250,000; in 1950, the number had increased to 76. Of the Nation's total population increase from 1940 to 1950, more than

four-fifths took place in the census' 168 standard metropolitan regions. This almost phenomenal importance of metropolitan regions in national growth poses one of the most serious planning problems for all types of transportation.

The increasing mobility of persons and goods has tended to disperse residential, manufacturing, and trade activities into the outskirts of metropolitan cities. As a consequence, the increasing use of automobiles and trucks may be expected; some experts anticipate a 75 percent increase in highway traffic in the next 25 years. The impact this will have on the metropolitan highway network is obvious.

Major traffic flow in a metropolitan area is between the central urban core and this expanding periphery. Radial expressways of the modern limited-access type require substantially wider rights-of-way than the older forms of highway. Major airports in a metropolitan region would normally be located near existing or proposed trunk routes and directly accessible to at least one of them. Integration of airport plans with the present and future highway network is therefore essential in order to assure accessibility and to prevent conflict of proposed highway routes with airport plans.

Planning of the airport facilities network must be made a part of the regional development plan if the latter is to be an effective guide to governmental policy. Studies of the airways traffic pattern, and of access by ground and air, are important to the success of an airport. They are of even greater significance to the community that supports it. If we are to achieve a good air transportation system in the metropolitan region, a major reshaping of the urban structure is called for. Such reshaping cannot be accomplished without the help of a clear concept of the optimum pattern of airports and airways in an idealized region.

The reservation or purchase of land for air terminals, together with adequate controls over areas within its influence, requires effective planning at the regional level. Some form of metro-

politan government would seem to provide the best answer, but in the immediate future other means—perhaps county, State, or Federal—must be found to achieve an integration of physical development in urban regions which are made up of a number of independent political units.

The unfavorable relationships between airports and the neighboring communities have been occasioned by disturbance or hazard to the property owner adjacent to airports, and by flight inconvenience to airport operators. If we are to avoid compounding our difficulties, it will be necessary to keep two ideas in mind: first, that airports must be planned as a part of the *total* system of metropolitan transportation and land use; and, second, that a sound idea of an optimum pattern must be created, so that immediate actions can build up to more than piecemeal and contradictory results.

Comprehensive urban planning usually involves three major steps: (1) gathering all pertinent facts and knowledge; (2) analysis of the data collected to establish basic interrelationships, future needs, and planning criteria; and (3) application of the criteria and data to an urban area and preparation of the master plan. It should not be thought that airport planning can be carried on independently. Its problems are seen to diverge at many points from the problems of total master plan preparation. However, there are important areas of interdependence. It is because of this alignment of interests that the master plan and airport plan are here recommended for collateral development.

The first step is collection of facts and knowledge. The scope of this material is what determines how comprehensive the final plan will be. For the general master plan, facts collected usually cover: (1) physical and climatic conditions, (2) economic resources, (3) population, (4) land use, and (5) physical facilities. Data on these subjects, where possible, should include past trends. For airport planning, these same subjects must be covered but in different detail.

Along with the factual data, planning criteria and principles

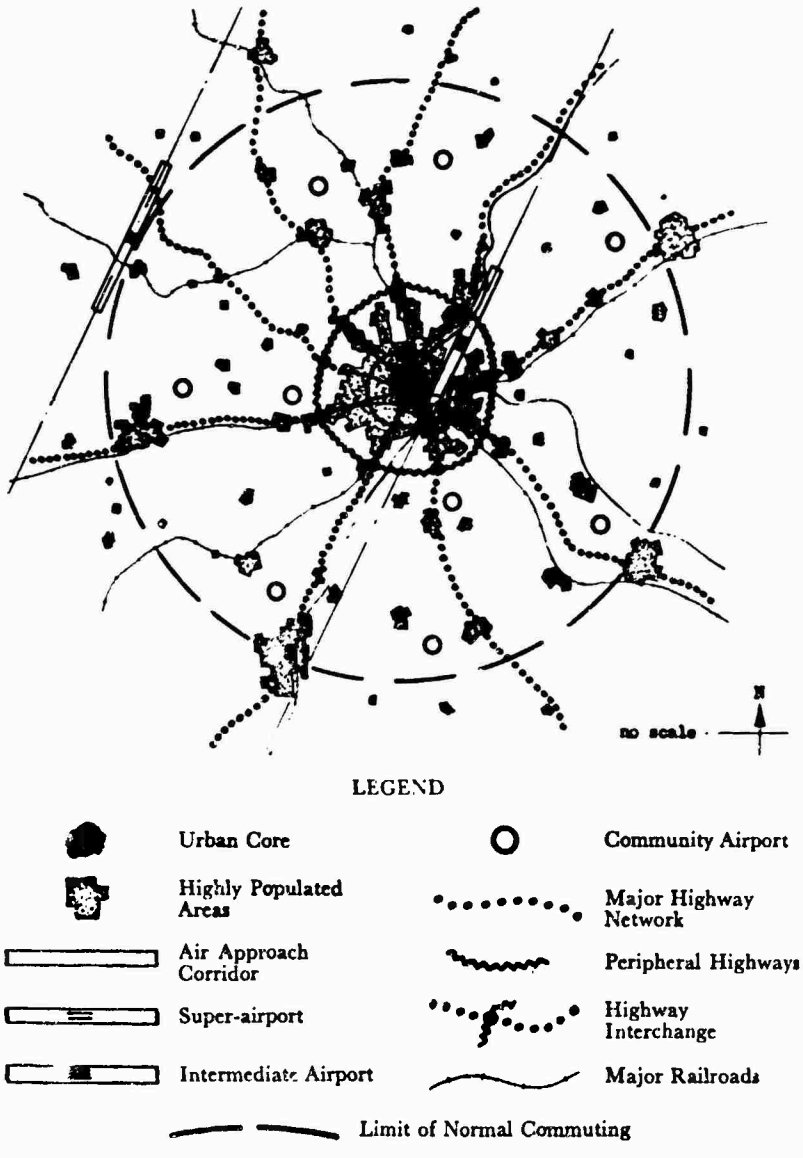

FIGURE 11. An idealized arrangement showing how airports of the future should be geared into regional master plans. Particular consideration should be given to convenient access to airports from traffic sources. Outer circle bounds normal commuting limit (20- to 40-mile radius).

are surveyed. Density, highway and street, parking, school and recreation standards are a few of the criteria sought. For airport planning, the criteria are in most respects different from those used in planning other features of the comprehensive plan. In general, it may be said that airport standards deal with questions of size or number, physical design, general location, and specific location.

The second step is analysis of the collected material. Essentially the objective here is (1) to determine the future requirements of the metropolitan region, (2) to determine the future planning criteria or standards, and (3) to determine important interrelationships in the master plan. Most of these objectives require intensive research before adequate assumptions can be made. This is found to be especially true when comprehensive planning is applied to air transport. The future requirements, standards, and interrelationships of airports and airways have not been given the attention they deserve.

Examples of specific criteria and data needed in this step are: air transportation service required by region in future; location with respect to major land use areas; location with respect to other regional transportation systems; relationship of air terminals to bordering land uses and facilities, etc.

The final step is the preparation of the master plan itself. Usually separate maps are prepared which emphasize each important element—land use, transportation, schools, recreation, to name only a few.

An Idealized Airport-Community Plan

The various aspects of airport-community planning can, perhaps, best be examined in a theoretical example. As the chart on page 84 indicates, one of the criteria of the idealized plan is the single runway airport. The advent of this criterion for airport design introduces an important economy to airport development, and provides a stabilized basis for design and location. Although the prevailing wind component has been an important

determinant in the past, intensely developed urban areas must now be considered equally important factors. The single or parallel runway principle is the basis for determination of land uses and obstacle restrictions in the runway approaches. The influence of airports on land uses and land values can thus be restricted to a limited segment of the airport periphery. As earlier sections have made clear, air traffic utilizing single or parallel runway airports will be subject to greater controls than are now prevalent and will, in time, assume a regulated and predictable pattern. In future planning, the approach zone must always be considered as embracing the full transition from runway to navigable airspace. As now proposed this air approach corridor would extend two and one-half miles beyond each end of the runway. It may in time need to be much longer. Surface land uses in the corridor area must be controlled, in varying degree, from the runway to the limits of the glide angle of approach.

The location of the approach corridor, superimposed over other regional uses, produces a new problem in the development of the regional plan. Two major orientations, the radial and the tangential, present important considerations:

(a) The radial orientation, as diagrammed near the center of the chart on page 84, conforms to the basic metropolitan pattern. It can be located parallel to major urban surface transport lines which radiate from the city's center.

(b) The tangential layout imposes a block in the development of the urban land use pattern. Its best application would be in areas remote from urban development.

(c) The most important plan consideration is the proper relation of each airport with the other. The maximum control of large volumes of air traffic requires the organization of air traffic without conflicts in procedure. It is necessary to avoid the intersection of traffic patterns, and this implies that air corridors be planned in parallel.

The delineation of the air corridor provides a basis for an

arrangement of land uses in the area of greatest nuisance and hazard. The major problem is in the arrangement of uses competing for space with the proposed corridor. Land space in the urban region is not so scarce that a reasonable plan is impossible. Large portions of the corridor may be planned to coincide with areas of public ownership. The control of land uses in the air corridor and of land uses in the areas adjacent to the airport reservation provides safeguards, both from encroachment on air operations and danger or disturbance to the community.

Classification for Planning

Functional and locational requirements of air terminals are a basis for airport planning. Classification of airports follows inevitably. Flexibility in the expansion of facilities and operations, and a demand for the interchangeability of aircraft types using those facilities tend to reduce airport classification to common denominators. The single runway principle simplifies the process. Although it applies to all airports, it must be qualified by variations imposed by different aircraft approach characteristics. These are the logical classifications:

Community. The local airport is designed for short-range movement in light and small aircraft. This type may be further subdivided into public and semi-public use categories (scheduled, taxi, courier, charter service, flight schools) and private use (individual commuting, pleasure, business). Although the single runway principle is applicable to all airport types, to varying degrees, both the location of the community airport and the operating characteristics of the aircraft that use it necessitate a considerable flexibility in design. Such airplanes at present have lesser cross-wind capabilities than transport craft; at the same time, they offer little nuisance or hazard. The economy of maintaining the community airport demands that it be located in an area common to the greatest number of users. Access to the site from all directions by both air and surface transportation is a firm requirement.

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Intermediate. The inter-metropolitan type is characterized by many existing airfields (feeder, trunk, express, continental) with multi-runway designs. Retention of this type is predicated on the feasibility of integrating the single runway principle on the existing site. Location will also depend on the economic and operational factors inherent in the area it serves. A metropolitan area may need several intermediate airports to service the peculiar requirements of its commercial, industrial, and residential areas. The value of the airport facility is delicately balanced on time-distance relationship to its support area.

Super-airport. The classification of "super" implies the use of the heaviest and fastest aircraft engaged in continental or intercontinental travel. The super-airport becomes the nucleus of a new segment of the urban region. The future design requirements, as well as its special uses, permit its location in an area remote from urban development. It will probably be the only facility of its kind in the metropolitan area, due to its long-distance function. The close logistical support of traffic volumes generated by commercial, industrial and residential users will be handled by the intermediate airports. Land uses in the area adjacent to the super-airport will require the same careful planning consideration and safeguards from encroachment.

Research for Planning

Substantial improvement in the techniques available to the airport planner is largely dependent on more intensive research into some of the basic problems that have been briefly dealt with in this report.

These include: (1) The interpretation of changes in aircraft characteristics as they influence the size, shape and location of airports. Examples include cross-wind landing ability, take-off and glide angles, external noise levels, safety, dependability, and size. (2) The coming changes in air activity and their influences on airports, including air cargo development, helicopter shuttle or taxi services, and private flying. (3) The problem of devel-

oping specific locational standards such as: How far apart should airports be? How far should airports and flight paths be from various land uses? What surface transportation connections are needed or justified? (4) A careful analysis of *all* costs and benefits, social and economic, direct and indirect, accruing to the industry, the consumer, and the general public, which result from air operations in a community or metropolitan region.

The development of a good air transportation system rests on a clear understanding of its collateral problems in the community and region. Our understanding has been weak in the past regarding rail and motor transport. However important they were in the development of our great cities, these forms are in general poorly related to the areas they serve and influence. The same mistakes should not occur in the development of our airways and airports.

Part VI

A SURVEY OF NATIONAL AIRPORT POLICY

Part VI. A Survey of National Airport Policy

The expansion of civil aviation following the celebrated New York-to-Paris flight of Charles A. Lindbergh in 1927 brought profound changes in national airport plans and policies. The days of cow-pasture flying were over and both the aviation industry and the public realized that the standard 100-acre sod fields, with their 1,500-foot cinder or gravel runways, suddenly had become obsolete. Take-offs for trans-Atlantic or other long range flights could be undertaken only from 3,000 to 4,000-foot strips. Concrete runways made their first appearance.

The expansion of the late 20's was accomplished without Federal assistance. It frequently was an expression of municipal rivalry, a competition between cities for airline services, air mail, or simply for prestige. This uncontrolled boom was first slowed and then halted by the depression. In 1933, following the collapse of private and municipal investment in airports, the first Federal aid was extended by the Civil Works Administration. By 1939 successive Federal works agencies had distributed some $139 million, which were supported by sponsor's funds amounting to about $187 million. Thus, in 6 years, a total of $326 million were made available for airport maintenance and expansion.

This period saw important changes in the status of airports and in the direction of the aviation industry. Subsidized by the Federal Government on a "matching fund" basis and owned and operated by States, counties, or municipalities, civil airports were established as public utilities. At the same time, aviation settled on a course of development toward larger, more powerful and faster airplanes. The mass production and sale of small personal airplanes, expected by some enthusiasts to parallel the case of the automobile, did not come about. Instead, the great-

est amount of money for civil aviation flowed into large commercial air transport enterprises and the facilities needed for them, including large, hard-surfaced, multiple-runway airports.

Since there was not the expected increase in interest in personal aviation, more small fields were built than were required. More recently the growth of commercial and agricultural uses of airplanes has resulted in renewed demands for additional small airports and landing strips.

Federal aid for airports, begun as an emergency measure, was continued under the Civil Aeronautics Act of 1938. By the end of World War II, total Federal expenditures for civil airports had reached $705 million. Of this, $331 million were expended from 1940 to 1945 by the Civil Aeronautics Administration, under the Development of Landing Areas for National Defense program, for airports essential to the national defense.

The Federal Airport Act of 1946 established a continuing program of Federal airport aid at a rate not to exceed $100 million per year with an authorized total of $500 million. Unfortunately, the implementation of this program by yearly appropriations has lagged; furthermore, it has proved difficult to synchronize the "matching" of funds, Federal and municipal. To date only about $169 million of Federal matching funds have been appropriated under the Act and the prospective appropriation for the coming fiscal year is less than $15 million. It is understood that there are now over $75 million of local matching funds available in communities for desirable projects. A firm decision should now be made as a matter of national policy to continue the Federal-Aid Airport Program at a sufficient level to match local funds. If this cannot be done consideration should be given to discontinuing this program. Then local communities will realize that they must bear the full costs of airport construction and improvement. National interest requires that airport improvements not be delayed. For the present, the limited funds available for Federal aid should be used for those airports contributing most to national production, national defense and overseas air-

lifts. The CAA has attempted to do this. The needs of such projects transcend local interests and airports concerned are included in mobilization calculations of logistics.

Today's investment in civil airports cannot be stated with accuracy. Many of these airports or portions of them were acquired from the military as war surplus, and many other airport facilities have been financed by private interests. However, it is estimated that the acquisition cost of all U. S. civil airports, with their ground establishments, is in the vicinity of $4 billion. Under the Airport Act, Federal funds are channeled either through States or directly to municipalities, in accordance with the provisions of the particular State law. In some cases, a State has participated financially as sponsor, or co-sponsor, with the muncipality. In general, such State participation has been relatively minor.

Some effort has been made to carry out a program of obstruction zoning. Little, however, has been accomplished in the direction of restricting land use in flight approach zones—the areas which produce the most violent and adverse public reaction to air activities. Largely because of lack of funds, the CAA has been slow to rearrange traffic facilities and to use radar for control of air traffic via population-free corridors. At the same time the hazard to persons living near airports has increased, due to the greater volume of traffic and to the greater size and speed of airplanes now in general commercial use.

Municipal airport planning has had difficulty adjusting to the "Since Korea" emergency. Earlier, the municipalities had been conditioned to the idea of either an all-out peace or an all-out war. They were not prepared for the problems of limited repossession of some fields by the military.

A typical airport now represents a substantial investment of municipal funds. When it was new and not busy, there was usually an aggressive campaign to increase activity on the airport, particularly by the sponsors who were desirous of vindicating their faith in aviation. Under these conditions, the mili-

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tary were often urged to use the airport. As the airport and its activities grew, there came a time when saturation was reached and it became expedient that some activity move off. The military, once urgently solicited, then became unwelcome. By this time the military might have made an investment of millions in the airport and quite naturally were loath or unwilling to move. In the past this could not be helped since there was no way to anticipate the phenomenal growth of aviation. In the future, with proper municipal and military planning, such misunderstanding should be avoidable. National policy should require thorough planning and coordination of the construction and use of airports by both civil and military authorities before requests for funds are submitted.

Joint use of congested airports by civil and military aviation is undesirable unless economic or other conditions make it necessary. It is particularly undesirable when the military airplanes are armed, carrying bombs or droppable fuel tanks and when they are very different from the civil in performance. Additional appropriations will be required for new military airfields before some air defense units can move from civil airports.

If it is necessary to base a military training unit on a civil airport, training should be conducted away from the built-up areas and an auxiliary field, located a safe distance away, should be used for arming. The planes should fly to the auxiliary field unarmed. Navy and Air Force Reserve training should be conducted at the same military airport wherever such consolidation is practicable and where economies will result. This practice becomes increasingly attractive as training shifts from piston- to jet-type airplanes, as existing Reserve training airports become obsolete, and if the requirements for new airports are not met by adequate appropriations.

Air Force and Naval Air Bases at which large numbers of men are to be stationed need to be reasonably near cities that can furnish the recreational and cultural facilities necessary to morale and general welfare. On the other hand, the presence of such

an air base creates not only advantages to the city but also problems of noise and hazard as well as social and economic dislocations of concern to the citizen taxpayers. For these reasons, the Commission believes that every effort should be made to arrange the location of new military air bases in accordance with city and regional development plans as an integral part of such planning.

Where military airports have become objectionable to their neighbors consideration should be given, within the limits of sound military practice and operational requirements, to the reassignment of some military units so that the least objectionable will be based there. For example, military air transport or troop carrier units cause the least interference with commercial air transport operations and ordinarily cause less noise and hazard than bomber or air defense units.

Military airport policy, like the civil, has suffered from faulty coordination, shortsighted planning and inability to secure necessary appropriations. The investment value of military airports (together with facilities thereon) in the United States is approximately $6 billion acquisition cost, and is increasing at the rate of some eight percent per year. The trend since the outbreak of the Korean situation has been toward more and larger airports. The differences in function of the several classes of military airports (basic training, advanced training, air reserve training, national guard, research and development, production, fleet support, strategic bomber, tactical air and air defense) lead to differences in planning criteria for selection and use.

A program of airfield zoning has been included in military planning policy, to protect both investment and ability to expand. Due, in part, to increased modern military aircraft requirements this has proved difficult and has been only moderately successful. Except for obstruction zoning, it has proved financially impracticable to restrict land use.

By reason of its close disciplinary control over pilots, military aviation can enforce reasonable adjustments of flight patterns in consideration of people below. Much more must be done to

balance the increased weight, speed, and size of military aircraft. Appropriations will be required to provide military airports in clear areas tied to communities by high-speed surface or by air shuttle transportation in order to relieve the situation appreciably.

The trend of military aircraft design and military economics is forcing the military to adopt the single runway policy, wherever weather conditions permit. More detailed forward planning, intensified pressure for zoning the dominant runway approaches and exits, and more attention to aircraft undercarriage design features, not inconsistent with combat requirements, are clearly in order.

Both military and civil policies have advanced significantly in the application of the "systems" approach to airport planning. Realization has come that an air transportation system consists of three coordinate parts—aircraft, traffic control and airports. The Airport Use Panel has been formed as a part of the Air Coordinating Committee to ensure more systematic planning of airports, particularly those involving joint use or interaction between military and civil. The value of this Panel as a planning and coordinating mechanism is already evident and will increase if it is strongly supported by ACC.

Summarizing, both civil and military airport policies require greater funding support and more comprehensive forward planning. If this report can contribute to this end its authors will be gratified.

APPENDIX

Appendix

Section 1. Organization and Procedures

The President's Airport Commission was organized under a Presidential directive issued at the White House on February 20, 1952. Members of the Commission met with the President in the White House to receive his personal instructions at noon on that day.

The first full meeting of the Commission was held on Tuesday, February 26. In the interim, the several advisors from the military services, from the Civil Aeronautics Administration, the Civil Aeronautics Board and from the National Advisory Committee for Aeronautics had been appointed, and an operations and organization plan had been drawn up. The Department of Commerce undertook to perform the housekeeping and servicing functions for the Commission. Thanks to its cooperation, office space was promptly assigned, efficient stenographic and secretarial help was detailed, telephone services were provided and the Commission was actually in business by the day following its first meeting. Organizational meetings were held in late February and a working schedule was developed.

In the period March 4 to March 24, a large number of organizations, both within government and without, met with the Commission to give their views on the problem before it. During the same period, a questionnaire was forwarded to the mayors of 104 cities of the United States where airports were considered critical, either from the standpoint of population or high traffic density. All organizations that were known to have an interest in the airport problem were requested to submit written statements

for Commission use on or before April 7. The response from both the cities and the interested organizations was most gratifying and yielded much valuable information.

On March 25, 26 and 27, the Commission conducted a series of meetings in New York City in which the National Air Transport Coordinating Committee, the Port of New York Authority, and the Offices of the Mayor of New York, and the Mayor of Newark gave the Commission their views on the situation in that critical area. A number of civic organizations which had protested the continued existence of the Newark and New York Airports on the grounds of hazard and nuisance were also heard.

Between March 28 and April 5, the Commission and its staff made a 9-day survey of 16 major airports throughout the United States. The program included conferences with Mayors and/or other officials of Atlanta, New Orleans, Fort Worth, Dallas, Wichita Falls, San Diego, Los Angeles, Burbank, Long Beach, San Francisco, Oakland, Colorado Springs, Denver, Kansas City, St. Louis and Chicago. The U. S. Air Force supplied an airplane and crew for this trip. This courtesy saved much time for the Commission.

During April, the Chairman conducted conferences and field inspections at Miami and Minneapolis. Mr. Horne inspected airports and held consultations with territorial officials in Hawaii and with city officials in Honolulu, Seattle, Portland and Spokane. Mr. Hunsaker visited the Boston area for a similar purpose, and Mr. Hunsaker and Mr. Doolittle inspected the civil and military airports in the Washington-Baltimore area. Also, staff teams visited Pittsburgh, Cleveland, Detroit and Philadelphia. Alaskan airport problems were discussed in Washington with Alaska's Governor, the Honorable Ernest Gruening. Altogether some 30 airports in the United States were personally inspected by the Commission or its staff. These inspections were extremely valuable in supplementing the statistical data that had been furnished by the mayors of the several cities in response to the questionnaire.

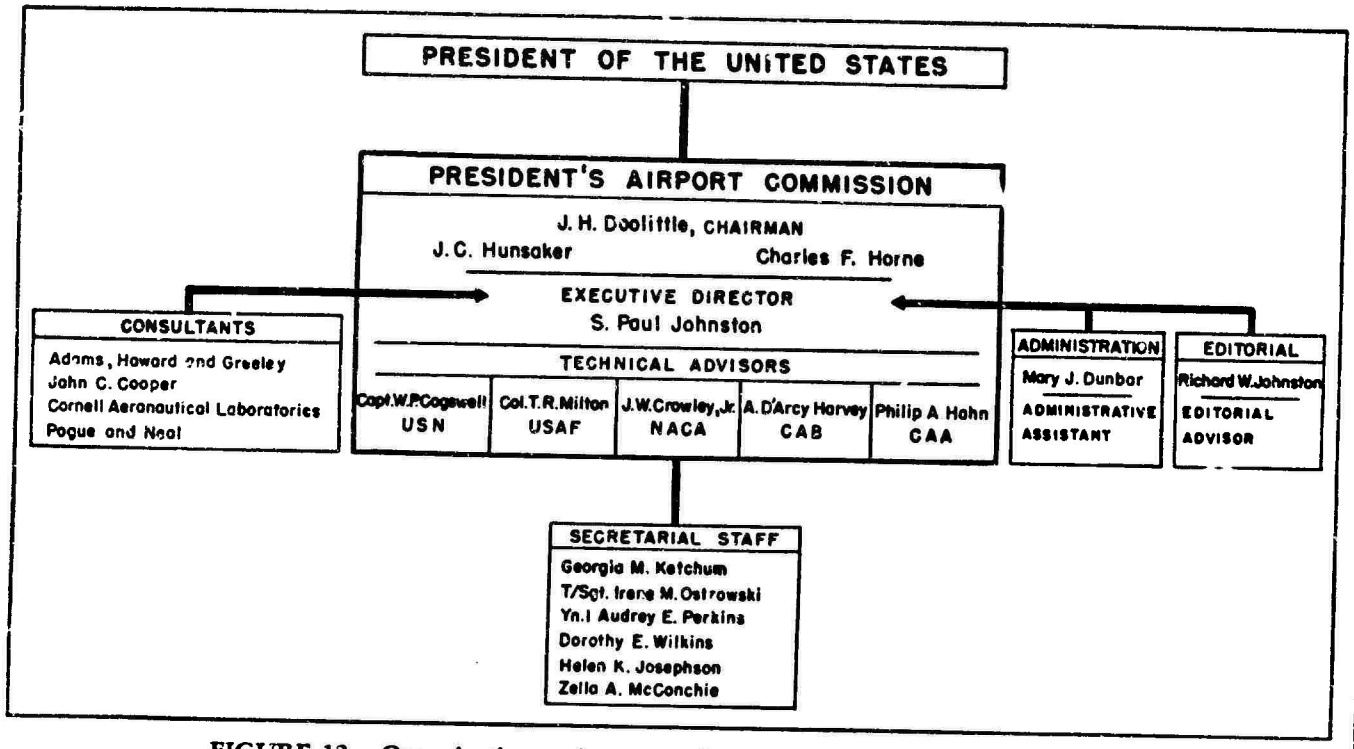

FIGURE 12. Organization and personnel—President's Airport Commission.

During the month of April, meetings with various government and airport organizations were continued in Washington. Meanwhile, supplementary written statements were received from many of the organizations which had been consulted during March and these were analyzed.

In the course of its study, the Commission consulted with some 264 individuals and received written or oral statements from 42 organizations.

All written material submitted and transcripts or summaries of conferences are filed with the records and working papers of the Commission.

The Commission wishes to express its sincere thanks and deep appreciation to all who appeared before it or submitted written material for its consideration.

The Commission is particularly grateful to the staff for its competent handling of the many details of the study and for the preparation of working papers.

Section 2. Acknowledgments

A. The cities listed below supplied detailed briefs of their local airport conditions in reply to the Commission's Questionnaire of March 7, 1952.

Akron-Canton, Ohio
Amarillo, Tex.
Atlanta, Ga.
Austin, Tex.
Baltimore, Md.
Birmingham, Ala.
Boston, Mass.
Buffalo, N. Y.
Charlotte, N. C.
Chicago, Ill.
Cincinnati, Ohio
Cleveland, Ohio
Columbus, Ohio
Corpus Christi, Tex.
Dallas, Tex.
Dayton, Ohio
Denver, Colo.
Detroit, Mich.
Duluth, Minn.-Superior, Wis.
Fort Worth, Tex.
Greensboro, N. C.
Greenville, S. C.
Hartford, Conn.-Springfield, Mass.
Indianapolis, Ind.
Jacksonville, Fla.
Kansas City, Mo.
Knoxville, Tenn.
Los Angeles, Calif.
Louisville, Ky.
Lubbock, Tex.
Macon, Ga.
Madison, Wis.
Memphis, Tenn.
Miami, Fla.
Milwaukee, Wis.
Minneapolis-St. Paul, Minn.
Montgomery, Ala.
New Orleans, La.
New York, N. Y.
Norfolk-Portsmouth, Va.
Omaha, Nebr.
Orlando, Fla.
Philadelphia, Pa.
Phoenix, Ariz.
Pittsburgh, Pa.
Portland, Oreg.
Providence, R. I.
Raleigh-Durham, N. C.
Richmond, Va.
Rochester, N. Y.
Sacramento, Calif.
St. Louis, Mo.
Salt Lake City, Utah
San Angelo, Tex.
San Bernardino, Calif.
San Diego, Calif.
San Francisco, Calif.
Savannah, Ga.
Seattle-Tacoma, Wash.
Spokane, Wash.
Tampa-St. Petersburg, Fla.
Topeka, Kans.
Tulsa, Okla.
Utica-Rome, N. Y.
Washington, D. C.
Wichita Falls, Tex.
Wilmington, Del.
Youngstown, Ohio

B. The following cities were visited by the Commission and/or its Staff. The individuals listed participated in supplying information regarding local conditions.

ALEXANDRIA, VA.

C. F. Watkins, City Manager; Floyd Williams, City Attorney.

ATLANTA, GA.

John H. Gray, General Manager, Dept. of Aviation; Jesse Draper, Vice Chairman, Aviation Committee.

BALTIMORE, MD.

Walter F. Perkins, Chairman, Airport Board; Gen. Donald H. Connolly, Director, Department of Aviation.

BOSTON, MASS.

Crocker Snow, Director, Massachusetts Aeronautics Commission; Albert L. Edson, Manager, Boston-Logan Airport.

BURBANK, CALIF.

Louis W. Wulfekuhler, Secretary, Lockheed Aircraft Corp.

CHICAGO, ILL.

Hon. Martin H. Kennelly, Mayor of Chicago; Ralph H. Burke, Airport Consultant; John E. Egan, Chairman, Aviation Commission; Oscar Hewett, Commissioner of Public Works; Merrill Meigs, Chairman, Aeronautics Commission; John Melaniphy, First Assistant Corporation Counsel; Clarence Woger, Chairman, Finance Committee.

CLEVELAND, OHIO

Hon. Thomas Burke, Mayor of Cleveland; Capt. William Allen, (AA) ALPA; N. J. Betz; E. W. Cleveland; John Dolan, Law Department; John A. Doyle, Jr., Lakefront Airport; Ben T. Franklin, Business Manager, Air Foundation; John F. Hehir, representing County Commissioners; Claude F. King, Airport; J. Morgan Lauer, Airport; James Lister, City Planner; Donald Patrick; Dr. E. R. Sharp, NACA; Robert Shea, Cuyahoga County Airport; H. B. Wharton, Eastern Air Lines.

DALLAS, TEX.

Hon. J. B. Adoue, Mayor of Dallas; George Coker; Charles Ford; Cecil D. French; Bernard Hemphill; Dr. George A. Schenewerk; H. P. Kucera, City Attorney.

DENVER, COLO.

Hon. Quigg Newton, Mayor of Denver; D. G. Davis, Director of Aviation.

DETROIT, MICH.

Col. C. V. Burnett, Director of Aviation; LeRoy Smith, Engineer-Manager, Wayne County Board of Road Commissioners; H. E. Baker,

Engineer-Manager, Detroit Wayne-Major Airport; John McElroy, Personnel Manager, Wayne County Board of Road Commissioners; Col. Robert Miller, ANTSCO, Inc., Willow Run Airport; J. P. Weidenbach, Manager, Willow Run Airport.

FORT WORTH, TEX.

Hon. J. R. Edwards, Mayor of Fort Worth; W. O. Jones, City Manager; Raymond Buck; Amon Carter; William Fuller; Maury Huffman; J. R. Pelich.

HAWAII (INCLUDING HONOLULU)

Governor Oren Long; Admiral Arthur W. Radford and Staff; O. J. Burnett, Member Hawaii Aeronautics Commission; Col. W. S. Dawson, PACDIVMATS; Peyton Harrison, Director, Hawaii Aeronautics Commission; E. E. Hart, Trans-Pacific Airlines; Capt. Bertram J. Hogg, Hawaiian Airlines; William S. Holloway, Hawaii Aeronautics Commission; Ralph C. Honda, Hawaii Aeronautics Commission; F. P. Jones, United Air Lines; Clark M. Kee, Hawaii Aeronautics Commission; Elmer G. Leehman, AOPA of Hawaii; Lee Maice; Walter F. McGuire, United Air Lines; Howard Phillips, ALPA; Capt. G. G. Price, CNAB; Francis K. Sylva, Chairman, Hawaii Aeronautics Commission; B. J. Talbot, Northwest Airlines; C. M. Wall, United Air Lines; Bo Tong Wat, Hawaii Aeronautics Commission.

KANSAS CITY, MO.

Louis R. Inwood, Director of Aviation; William Green, Superintendent, Fairfax Airport, Kansas City, Kansas.

LONG BEACH, CALIF.

Hon. B. W. Chace, Mayor of Long Beach; Mr. Vickers, City Manager; Harold Levy, Administrative Assistant to City Manager.

LOS ANGELES, CALIF.

Hon. Fletcher Bowron, Mayor of Los Angeles; Ray W. Smith, President, Board of Airport Commissioners; Robert L. Smith, Former President, Board of Airport Commissioners; Ben P. Griffith, Commissioner; Thornton Sargent, Commissioner; J. A. Hartley, Commissioner; Courtland Smith, Secretary; J. W. Reeves, Jr., General Manager, Los Angeles Department of Airports; M. T. Tucker, Airport Engineer.

MIAMI, FLA.

A. B. Curry, Director, Dade County Aeronautics Commission.

MINNEAPOLIS—ST. PAUL, MINN.

Vice Chairman and Commissioner Edward K. Delaney, Mayor of St. Paul; Secretary and Commissioner Eric G. Hoyer, Mayor of Minneapolis; Commissioner Frank D. Marzitelli, Councilman, City of St. Paul; Commissioner Frank V. Moulton, Alderman, City of

Minneapolis; Commissioner Fred T. Paul, Citizen Member; Commissioner Walter P. Quist, President, Minneapolis Board of Park Commissioners; Commissioner Milton Rosen, Councilman, City of St. Paul; Commissioner Fred M. Truax, Citizen Member; Robert Aldrich, MAC Executive Director; Montreville J. Brown, MAC Counsel; Royce B. Hansen, MAC Project Engineer; L. D. Hammond, MAC Wold-Chamberlain Field Director; H. C. Timberlake, MAC Economist; Croil Hunter, President, Northwest Airlines; Malcolm S. Mackay, Executive Vice President and General Manager, Northwest Airlines; Waite D. Durfee, Researcher, U. of M. Legislative Aviation Research; Capt. F. N. Howe, Commanding Officer, U. S. Naval Air Station.

NEW ORLEANS, LA.

D. O. Langstaff, Executive Director, Airport Board; Mr. R. B. Fowler, Administrative Assistant, Airport Board; Edward D. Rapier, Aviation Commission and Chamber of Commerce.

NEW YORK, N. Y.

Kenneth Baehr.

OAKLAND, CALIF.

Mayor Clifford E. Rishell and Staff; D. W. Frost, President, and members of Oakland Board of Port Commissioners.

PHILADELPHIA, PA.

Hon. Joseph S. Clark, Jr., Mayor of Philadelphia; Walter M. Phillips, Director of Commerce; J. Victor Dallin, Chief, Bureau of Aeronautics.

PITTSBURGH, PA.

John J. Kane, Chairman, Board County Commissioners; H. W. Fowler, Commissioner; J. B. Sweeney, Director of Aviation.

PORTLAND, OREGON

John J. Winn, Jr., General Manager, and Members of Port of Portland Commission.

SAN DIEGO, CALIF.

Hon. John D. Butler, Mayor of San Diego; J. Floyd Andrews, Manager Pacific Southwest Airlines; George Bond, Convair; Tom F. Bomar, San Diego California Club; Anderson Borthwick, Harbor Commission Chairman; John Braun, Manager, N. A. Airlines; O. W. Campbell, City Manager; Jean F. DuPaul, City Attorney; James Frazier, Manager, Trans-World Airlines; Kenneth Friedkin, Manager, Friedkin Aeronautics; Rear Admiral G. R. Henderson, Commander Air Bases, 11th and 12th Naval District; E. F. Jones, Convair; William K. Kellogg, Manager, Western Airlines; Capt. D. B. MacDiarmid, Commanding Officer, Coast Guard Air Station; J. S. Neel, Jr., Western

Airlines, Earl Prudden, Vice President, Ryan Aircraft Corporation; Glenn A. Rick, Planning Director; William Sample, Manager, American Airlines; R. C. Sebold, Convair; Philip Sharp, Manager, United Air Lines; Bernard Snyder, Manager, California Central Air Lines; W. L. Wilkinson, Solar Aircraft Company; Lt. Comdr. H. H. Woodward, Operations Officer, 11th and 12th Naval District; Joe Rust, Airport Manager, representing County of San Diego.

SAN FRANCISCO, CALIF.

Lawrence T. Broeron, Flight Manager, United Air Lines; George D. Burr, Senior Civil Engineer, San Francisco Airport; John H. Connelly, President, Southwest Airways; G. M. Dixon, Manager and Chief Engineer, San Francisco Airport; G. F. Maxwell, Operations Manager, Pan American Airways; H. S. Messersmith, Superintendent of Airport Operations, San Francisco Airport; Clarence M. Young, Vice President, Pacific Alaska Division, Pan American Airways.

SEATTLE, WASH.

Hon. W. F. Devin, Mayor of Seattle; George E. Treadwell, Chief Engineer, Port of Seattle; Rear Adm. Gordon Rowe, Secretary, Port of Seattle Commission; Dayton A. Witten, Airport Manager, Boeing Field; Dick Crowley, King County Airport-Boeing Field; D. C. Vaile, Northwest Airlines.

SPOKANE, WASH.

Willard Taft, Acting Mayor and City Commissioner; Representatives of Armed Forces, Chamber of Commerce and aviation industry.

ST. LOUIS, MO.

C. B. Briscoe, Director of Public Utilities and Chairman of Airport Commission; David Leigh, Airport Manager; H. F. Wagner, Planning Engineer, St. Louis County Planning Commission.

WASHINGTON, D. C.

Bennett H. Griffin, Director, Washington National Airport; Paul F. Steiner, Deputy Director, Washington National Airport; Herbert H. Howell, Director, Burke Airport Project.

WICHITA FALLS, TEX.

ADDITIONAL INDIVIDUALS WHO WERE CONSULTED

B. M. Doolin, State Aviation Commission, California.
Reed M. Chambers, U. S. Aviation Underwriters.
Howard Hughes, Hughes Aircraft Company.
Otto C. Koppen, Massachusetts Institute of Technology.
Arthur Raymond, Douglas Aircraft, NACA.
Howard Rusk, Chairman, Health Resources Advisory Board.

C. The following organizations supplied material in response to the Commission's Questionnaire of March 7, 1952. They were represented by the individuals listed.

AIR LINE PILOTS ASSOCIATION, INT'L.
Clarence N. Sayen, *President;* Larry Cates, *Washington Representative.*

AIR TRANSPORT ASSOCIATION OF AMERICA
Admiral Emory S. Land, *President;* Brig. Gen. M. W. Arnold, *Vice-President, Operations and Engineering.*

AIRCOACH TRANSPORT ASSOCIATION, INC.
Amos E. Heacock, *President;* Forbes Huffman.

AIRCRAFT INDUSTRIES ASSOCIATION OF AMERICA, INC.
Admiral DeWitt C. Ramsey, *President;* I. C. Peterson, *Technical Service;* J. T. Geuting, *Personal Aircraft Council;* D. R. Mockler, *Helicopter Council;* Leland D. Webb, *Western Region Manager.*

AIRPORT OPERATORS COUNCIL
Louis R. Inwood, *President;* Fred M. Glass, *Director;* Cyril C. Thompson, *Executive Secretary;* Leander I. Shelley, *General Counsel.*

AMERICAN ASSOCIATION OF AIRPORT EXECUTIVES
Cecil C. Meadows, *President.*

CENTRAL QUEENS ALLIED CIVIC COUNCIL, INC.
Albert J. Bregman.

CERRITOS PARK ASSOCIATION, LONG BEACH, CALIF.
H. R. Wyllie.

CITIZENS AIRPORT COMMITTEE, ELIZABETH, N. J.
A. W. Van Horn; E. W. Hague.

CITIZENS COMMITTEE OF SAN BRUNO AND BURLINGAME, CALIF.
Hon. Claude G. Fourie, *Mayor of San Bruno;* M. W. Slankard, *City Manager, San Bruno;* F. Clay Fisher, *Councilman;* R. L. Mayer; Otto McCaughan; Hon. Andrew Byrd, *Mayor of Burlingame;* Dan R. Love, *Councilman, Burlingame.*

COLLEGE POINT TAXPAYERS ASSOCIATION
Jonathan Fuchs.

CORNELL AERONAUTICAL LABORATORY, INC.
T. P. Wright, *President;* C. C. Furnas, *Executive Vice-President and Director;* L. R. Everingham, *Assistant Secretary and Assistant to Director;* R. H. Shatz, *Head, Special Projects.*

DENVER AIR SAFETY COMMITTEE
Louis Degan, Arthur Samelson; Porter Nelson.

EASTERN QUEENS CIVIC COUNCIL
Royal E. Dalrymple.

FLIGHT SAFETY FOUNDATION AND GUGGENHEIM AVIATION SAFETY CENTER
Jerome C. Lederer.

GLENDALE PARK IMPROVEMENT ASSOCIATION
Ray Swanson; E. F. Gerber.

INDEPENDENT AIR CARRIER CONFERENCE
John J. Klak, *Executive Secretary and Counsel;* Harry E. Middleton, Jr., *Secretary-Treasurer.*

INDEPENDENT MILITARY AIR TRANSPORT ASSOCIATION
Theodore Seamon, *Secretary and Counsel;* Ben B. Edwards, *Executive Director and Assistant to President.*

JACKSON HEIGHTS COMMUNITY FEDERATION
John J. Reardon.

LOS ANGELES AIRWAYS, INC.
Clarence M. Belinn, *President.*

NATIONAL AERONAUTIC ASSOCIATION
Donald D. Webster, *General Manager.*

NATIONAL AIR COUNCIL
C. S. Jones.

NATIONAL AIR TRANSPORT COORDINATING COMMITTEE
John Wiley; Les Barnes; Roy Chalk; A. M. Moser; C. R. Smith; E. V. Rickenbacker; William Van Dusen.

NATIONAL ASSOCIATION OF STATE AVIATION OFFICIALS
C. E. A. Brown, *President;* Crocker Snow; Richard A. Jamison; C. F. Cornish; A. B. McMullen.

NATIONAL FLYING FARMERS
E. M. Anderson.

NORTH QUEENS HOME OWNERS CIVIC ASSOCIATION
Harold W. Felton; Louis C. Moser.

POINT LOMA ASSEMBLY, SAN DIEGO
Mrs. Della A. Whitney; Mrs. R. W. Burlingame; Mrs. C. D. Palmer; Mrs. John Zweck.

PORT OF NEW YORK AUTHORITY
Howard S. Cullman, *Chairman;* Austin J. Tobin, *Executive Director;* Fred M. Glass; John F. Sly.

QUEENSBOROUGH COMMITTEE ON COMMUNITY AVIATION PROBLEMS
C. Clarke Masterson; Raymond J. Connolly.

QUEENS COUNTY GRAND JURORS ASSOCIATION
Anthony DeSeta; J. Rapp; Charles A. Barkie.

QUEENS UNITED CIVIC COUNCIL
Joseph McKenna.

SANTA MONICA HOME OWNERS
Mr. Pemberton.

SPRINGFIELD GARDENS TAXPAYERS AND CITIZENS ASSOCIATION
A. L. Montbellier.

VALLEY RESIDENTS ASSOCIATION, VAN NUYS, CALIF.
Paul Jertberg; Robert L. Patrick.

U. S. AIR FORCE—AIR DEFENSE COMMAND, COLORADO SPRINGS, COLO.
Gen. Benjamin Chidlaw, *Commanding General;* Brig. Gen. Kenneth P. Berquist, *Deputy Chief of Staff, Operations;* and members of Air Defense Command Staff.

U. S. AIR FORCE—MILITARY AIR TRANSPORT SERVICE
Lt. Col. S. P. Bettinger; Lt. Col. T. D. Collins.

U. S. AIR FORCE—WESTERN AIR PROCUREMENT DISTRICT, LOS ANGELES, CALIF.
Maj. Gen. Wm. M. Morgan, *Commanding General, Western Region, Air Matériel Command;* Lt. Col. D. F. Marshall, *Deputy Director for Production.*

U. S. CIVIL AERONAUTICS BOARD
Donald W. Nyrop, *Chairman;* Emory T. Nunneley, Jr., *General Counsel.*

U. S. FEDERAL COMMUNICATIONS COMMISSION
E. M. Webster, *Commissioner;* George Sterling, *Commissioner;* Richard Solomon; John Evans.

U. S. HOUSING AND HOME FINANCE AGENCY
Raymond M. Foley, *Administrator;* N. S. Keith, *Director, Division of Slum Clearance and Urban Redevelopment;* Curt C. Mack, *Assistant Commissioner, Federal Housing Administration.*

U. S. POST OFFICE DEPARTMENT
John M. Redding, *Assistant Postmaster General.*

U. S. VETERANS ADMINISTRATION
Maj. Gen. Carl R. Gray, Jr., *Administrator;* Col. Frank H. Dryden, *Assistant Administrator for Construction, Supply, and Real Estate.*

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